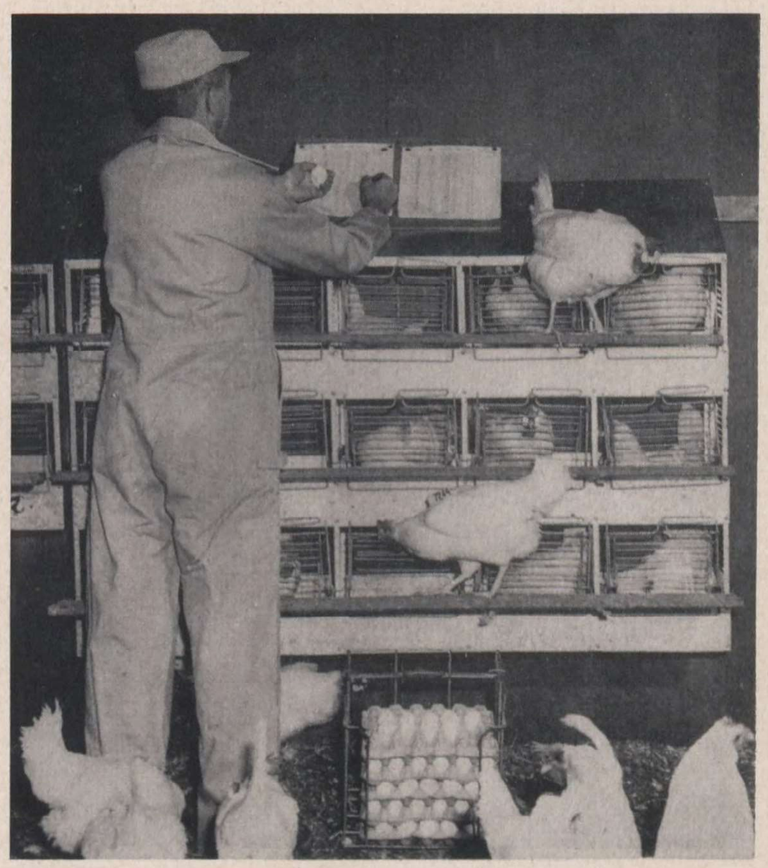
CANADA
DEPARTMENT OF AGRICULTURE
EXPERIMENTAL FARMS SERVICE

# POULTRY DIVISION

## CENTRAL EXPERIMENTAL FARM, OTTAWA

H. S. Gutteridge, B.S.A., M.Sc., Chief

## PROGRESS REPORT
## 1949 - 1954



Pedigree breeding starts with the trapnest.

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# PERSONNEL

## Poultry Division

## Central Experimental Farm, Ottawa

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# POULTRY DIVISION,

## Central Experimental Farm, Ottawa

## Progress Report, 1949-54

## INTRODUCTION

The previous Progress Report covered the period, 1937-48, and the current Report deals with the work of the Poultry Division from that time to the end of 1954.

The research of the Poultry Division continues to be concerned chiefly with the economically important problems in genetics and nutrition, investigations which require a highly trained staff and laboratory facilities. To a lesser extent, problems of management have also been investigated. The greatest effort is directed toward the domestic fowl, but some attention is given to research with turkeys and geese. In the case of the latter, a reasonably comprehensive research program in genetics, nutrition, and management is in progress.

In genetic research in particular, large populations of birds, preferably under a variety of different environments, are desirable. Because of this, the Poultry Division relies heavily on the co-operation of the Branch Farms throughout Canada. Collaborative research projects conducted at a number of Experimental Farms and at Ottawa make a major contribution to the research program. This co-operation is gratefully acknowledged; it permits the reporting of some of the genetic research herein that otherwise would not have been possible.

Improved methods of breeding and feeding for increased egg production, while maintaining the lowest possible level of morbidity and mortality, are the chief ends to which the research of the Division is directed. Similarly, production of poultry meat with the most efficient use of feed is attempted through the use of improved breeds or crosses and more efficient rations.

During the first half of the period covered by this report a relatively small amount of research work could be conducted because of a depleted professional staff. In 1948 there were only two professional research officers and for a period of more than two years there were only three officers. With appointments during the years 1950 to 1953, research work was resumed at a more satisfactory level.

Changes in the professional staff since the last Progress Report, (1937-48), are as follows:

Mr. S. Bird retired on March 15, 1952. Dr. J. R. Aitken was appointed head of the Nutrition section on July 13, 1951. Mr. A. B. Morrison joined the staff on September 23, 1952, and resigned on September 15, 1953. Mr. W. G. Hunsaker was appointed on October 15, 1952. Mr. G. S. Lindblad joined the staff on January 10, 1953 and resigned on November 30, 1955. Dr. J. R. Hunt was appointed on January 23, 1956. Mr. K. G. Hollands was appointed on December 27, 1956.



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## POULTRY BREEDING UNIT

*R. S. Gowe (Head), A. S. Johnson, E. S. Merritt*

The research of this unit has been directed, for the most part, towards improving the procedures being used by breeders engaged in improving egg and meat strains of chickens, turkeys, and geese. The importance of environment in the performance of egg and meat stock has long been neglected or minimized and extensive investigations on the magnitude of environmental influences and the interaction of various genotypes and environments have been undertaken. Procedures for controlling and separating genetic and environmental effects are being developed.

Since many traits of economic importance are dependent on the normal functioning of the reproductive system, studies in reproductive physiology have also been undertaken.

### Breeding Experiments

***Selecting for increased egg production:*** In 1950, a breeding experiment was initiated to investigate various problems associated with selection for higher egg production in closed flocks. In recent years some poultry breeders have been concerned because their flocks do not appear to be responding to selection, especially for higher egg production. The explanation could be, (*a*) that the selection pressure being exerted is less than the breeder thinks it is, (*b*) that selection is being exerted for more than one trait, and there may be a negative genetic correlation between these traits that would result in reduction of the effective selection pressure for either trait, (c) owing to various obscure genetic mechanisms, selection may in fact have gone as far as it can go by using breeding systems based on a closed flock.

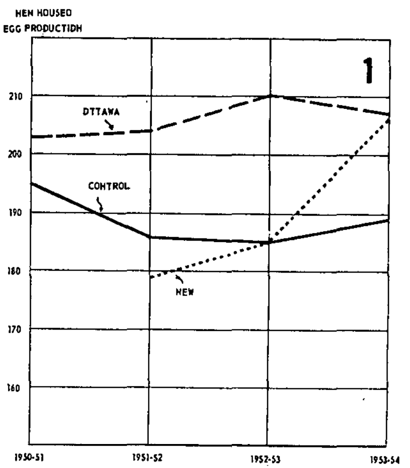
Environmental effects are so great for most economic traits in poultry that they may tend to mask any genetic improvement, or result in a very slow rate of genetic progress. To obtain estimates of environmental effects and to provide a means of measuring genetic progress, a control strain (a random-mated unselected strain) was formed at the time the project was started. This control strain was formed from the same base population as another strain, the Ottawa strain, which was subjected to selection. The control and the Ottawa strains had the same sires for the first year (1950-1951) and the females of the original population were assigned at random to the two populations for this base year.

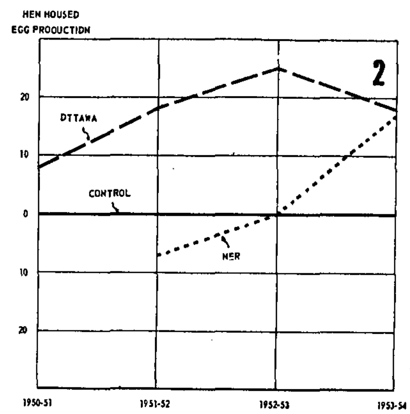
In 1951, another strain (called New strain) was synthesized from 7 Canadian strains of Leghorns. It has been under selection for two generations, while the Ottawa strain has been under selection for three generations in the present project and at least five generations prior to the start of this project. Because of its purposely constructed heterogenous background, it was thought that this synthetic strain might respond to selection in a different manner from the Ottawa strain which had a relatively narrow genetic base.

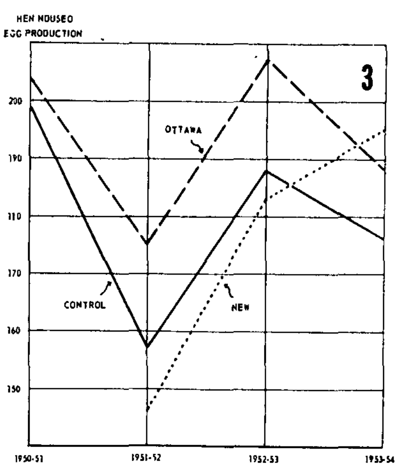
In this study, all of the breeding pens were located at Ottawa. At hatching random samples of each dam's and sire's progeny were placed on test at five Branch Farms and Ottawa—(Agassiz, B.C.; Lethbridge, Alta.; Morden, Man.; Harrow, Ont., and Charlottetown, P.E.I. Charlottetown did not receive stock until 1951).

Only the Ottawa samples of each mating were used for selection for breeding purposes although the genetic worth of this stock was estimated from a summary of their sib and half-sib records at all locations. Selection was based on individual, full-sib, half-sib, and progeny-test records. Part-year records were used for selecting pullets and cockerels to reduce the generation interval. Two "shifts" of cockerels were used to increase the number of cockerels tested per strain. Approximately 20 per cent of the breeding males and females were two years old and older.

By comparing the performance of the selected strains with that of the Control strain, it has been possible to estimate the rate of genetic progress. After three generations of selection, egg production (hen-housed basis) has increased by 18 eggs in the Ottawa strain, while only two generations of selection have increased the hen-housed egg production of the New strain by 24 eggs. On a survivor basis, the increase was less, 11 eggs for the Ottawa strain and 20 eggs for the New strain. While it is difficult to draw any positive conclusions with data from the two and three generations available, it appears at



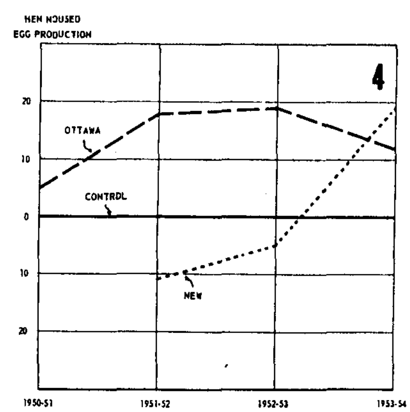




Figure 1. Mean hen-housed egg production of the two selected strains and the control strain on test at four farms for four generations.

Figure 2. The same data as in Figure 1 expressed as deviations from the mean performance of the control strain.

Figure 3. Mean hen-housed egg production of the three strains on test at Agassiz for four years.

Figure 4. The same data as in Figure 3 corrected for environmental fluctuations and illustrating the genetic trends in the selected populations. Note the general agreement between Figures 2 and 4.

this stage that it is easier to make progress in the strain with the broad genetic base. However, the New strain did not produce as well as the previously selected Ottawa strain at the start of the experiment, so it may be that its greater rate of genetic gain may not continue now that the two strains are nearly equal in egg production ability. The actual hen-housed egg production figures for the three strains on test at four stations (Agassiz, Lethbridge, Morden, and Harrow) are shown in Figure 1. These same data, expressed as deviations from the average of the Control strain, are presented in Figure 2 (the Charlottetown data were not included since this Farm did not receive stock until the second year and the Ottawa data were eliminated since the Control strain birds were not in the same pens as those of the other two strains throughout the test).

The value of the Control strain to poultry breeders in measuring their progress due to selection has been illustrated by the data from one Experimental Farm. In Figure 3, the actual records for the two selected strains for the four years at Agassiz are shown. It would be very difficult to draw any conclusion as to the rate of genetic gain from these data. When the same data are plotted as deviations from the Control strain, which was also on test at this location, it is possible to make a more accurate estimate of the genetic change (Figure 4). Note the similarity of the corrected trends at this location and for the four combined stations (Figure 2).

This control strain is being used to measure environmental trends in the Random Sample Egg Production Test being conducted by Production Service of the Department.

***Influence of environment on egg production and viability:*** Comparisons as to the genetic worth of strains that have been reared and housed at different locations are usually unsound, unless some correction can be made for the varying environmental influences.

In 1950, hatching eggs of commercial stock were obtained from 7 Canadian R.O.P. breeders to form the New strain, previously referred to. These eggs were hatched in the same incubator and the chicks were wing banded and then brooded and reared as a group. At housing time, at 160 days of age, pullets of the 7 strains were randomized into the laying pens and trapnest records of egg production were obtained up to 500 days of age.

The results obtained for two important traits, egg production and mortality, are shown in Table 1. These results are compared in the same table with the performance of the "official entry" under the R.O.P. policy. In the latter case, the pullets were reared on each breeder's farm and housed and tested there so that the "location" or environmental effects were confounded with the strain effects. In the comparison, there are several minor shifts in rank and one major shift. Strain B, which shifted rank so drastically, laid 75 less eggs per bird housed at Ottawa than the group housed on the breeder's plant. Obviously, one can determine the relative genetic worth of different strains only by a test of these strains at one location.

TABLE 1. A COMPARISON OF THE PERFORMANCE OF 7 R.O.P. STRAINS OF WHITE LEGHORNS AT THEIR HOME PLANTS AND AT OTTAWA 1950-1951

| Strain | Production index | | | | Laying house mortality | | | |
|---|---|---|---|---|---|---|---|---|
| | Ottawa sample | Rank | R.O.P. entry | Rank | Ottawa sample | Rank | R.O.P. entry | Rank |
| A | 210 | 1 | 234 | 1 | 17% | 1 | 7% | 2 |
| E | 203 | 2 | 168 | 4 | 17% | 1 | 13% | 5 |
| F | 199 | 3 | 200 | 3 | 19% | 3 | 13% | 5 |
| C | 165 | 4 | 168 | 4 | 24% | 4 | 12% | 4 |
| G | 164 | 5 | 139* | 7 | 29% | 6 | 30%* | 7 |
| B | 148 | 6 | 223 | 2 | 24% | 4 | 5% | 1 |
| D | 143 | 7 | 159 | 6 | 40% | 7 | 9% | 3 |

* Unofficial data—entry withdrawn.

To obtain more accurate estimates of the influence of environment on egg production, a series of experiments was conducted over the past four years, under conditions where every practical procedure was adopted to minimize environmental differences. In these experiments, five Experimental Farms co-operated with the Central Farm at Ottawa; they were Agassiz, B.C.; Lethbridge, Alta.; Morden, Man.; Harrow, Ont., and Charlottetown, P.E.I. The chicks for all units were hatched at Ottawa and shipped by air to the co-operating Farms. The ration, floor space, feeder space, hours of light and other easily controlled factors were standardized at all units, while the climate, soil, and pasture conditions during the rearing season, and those subtle factors associated with the management of the birds by different poultrymen were the uncontrolled "location" effects. Data from these experiments showed there was little correlation between climate and production or mortality. The Farms at Morden, Man., and Harrow, Ont., have an annual mean temperature difference of 11°F. and yet birds at both of these Farms laid at a higher rate each year than at the other locations. There is no doubt that the factors associated with the day-to-day practices of the poultry husbandmen are very important in determining the over-all results.

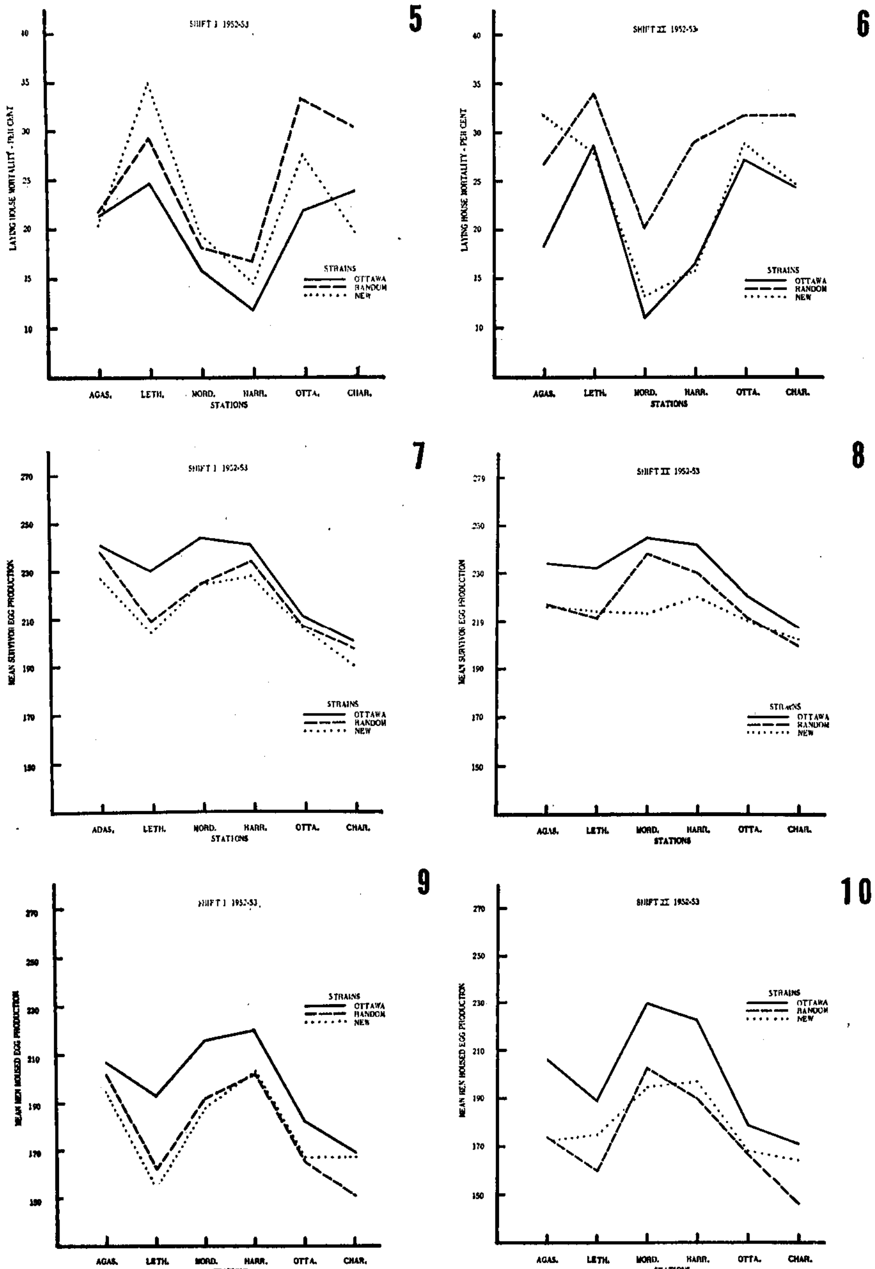
Despite the differences among locations, there was little evidence of any strain × location interaction; that is, there was no significant change in rank of the several strains at the different locations. Data from the year 1952-1953 illustrate this point in Figures 5 to 10. Strain × location interactions may be important where disease conditions are extreme or conversely where resistance to leucosis and other endemic poultry diseases is lacking in some of the strains being tested.

It is suggested that under most commercial conditions genotype × environment interactions are of little practical importance when quality of the feed and management practices are reasonably good. From these studies, we were able to conclude that centralized random sample egg production testing units are practical for comparing the genetic worth of commercial strains of egg-producing fowl.

***Comparison of the performance of seven Single Comb White Leghorn strains housed in laying batteries and floor pens:*** Extensive experiments have shown that there is little location × strain interaction when all birds are housed in floor pens under similar management conditions. However, there is no information as to how different strains react to extreme differences in housing conditions such as those between floor pens and individual-cage laying batteries.

In the experiment to be reported, eggs from seven strains of S.C. White Leghorns obtained from 7 different Canadian R.O.P. breeders were incubated in the same machine, and the chicks banded and reared together till 160 days of age. At this time, 42 birds of each strain were randomly assigned at 3 per strain to 14 floor pens, and 35 birds per strain were randomized over 3 decks of an individual-cage laying battery.

Mortality in the pens was 5 per cent higher than in the batteries. With respect to egg production the means of the 7 strains on test in the batteries and pens, both on a survivor and hen-housed basis, are shown in Figure 11. In only one case—Strain 2—did the battery production exceed that in the pens. Strains 2, 6, and 7 appeared to adapt themselves to the battery better than the other four strains.




Figures 5, 6, 7, 8, 9, 10. Percentage mortality, survivor and hen-housed production for pullets housed for three strains of White Leghorns at six branch farms. Data for 1952-53 laying year, with two shifts (four hatches) of males for each strain.

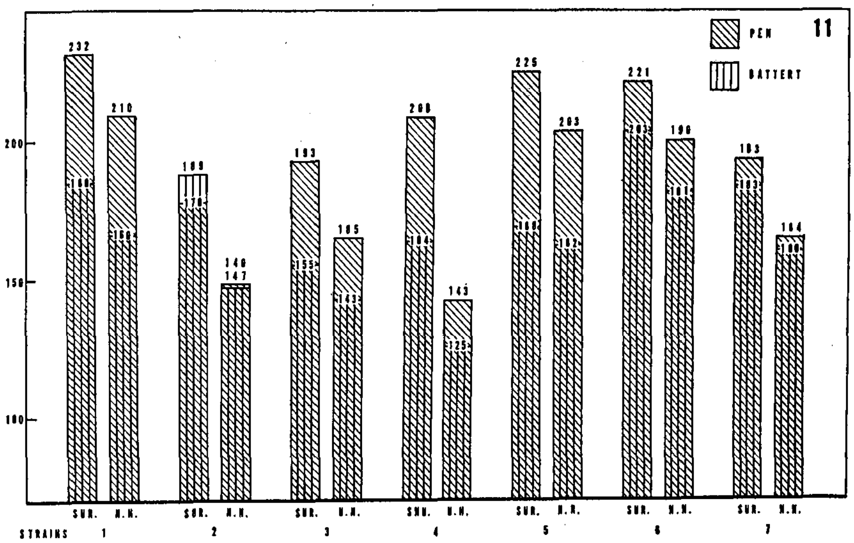



Figure 11. Mean hen-housed and survivor egg production for seven strains of birds on test in floor pens and in individual cage laying batteries. Note the differential response of the different strains to the two environments.

The interaction between location and strain for survivor egg production was highly significant. There was also a highly significant interaction between strain and location for March body weight. Differences in body weight between strains were much greater in the battery than in floor pens.

Poultry breeders selecting stock for laying cage operations should determine how a strain (or strains) performs in laying cages as well as its general genetic worth. Some Leghorn strains seem to be better adapted to cage operations than others. It may be that selection should be done under cage conditions by those breeders who supply commercial cage operators with production-bred stock.

***Heritability of economic traits in egg production fowl:*** Progress in selection for genetic improvement in any trait is dependent on the heritability of the trait in the flock, everything else being equal. Some traits, such as shank color, are 100 per cent heritable and can be fixed in a population in one or two generations. Most economic traits in poultry have low to moderate heritability and thus present a greater problem. Selection procedures that are effective for highly heritable traits are not necessarily the most efficient for traits with a low heritability. It is important to estimate the heritability of economic traits so that efficient selection procedures can be used. It is also important to see whether these genetic parameters change to any significant extent in a flock under intensive selection. If the heritability decreases as selection progresses, different selection procedures (such as increasing the emphasis on sib and progeny tests) may be required to maximize the genetic gain.

Heritability estimates for seven of the most important economic traits of egg production fowl have been calculated for two strains of S.C. White Leghorns based on the sire variance components within shift and within farm. Unweighted arithmetic means of the estimates obtained at each location are presented in Table 2. Sex-linked effects, if any, would be included in these estimates since they were derived from sire components only, but maternal effects would not influence them.

There would appear to be a difference between the New and the Ottawa strains in the heritability of hen-housed egg production, laying house mortality, egg weight and housing body weight although precise statistical tests of these differences are lacking. The estimates for the two strains are very similar for survivor egg production, sexual maturity, and March body weight.

TABLE 2. HERITABILITY ESTIMATES FOR 7 ECONOMIC TRAITS IN TWO STRAINS OF EGG PRODUCTION WHITE LEGHORNS

| Years | Strain | Egg production | | Laying house mortality | Sexual maturity | March egg weight | Body weight | |
|---|---|---|---|---|---|---|---|---|
| | | hen-housed | survivor | | | | housing | March |
| 1950–51 | Ottawa | .083 | .147 | .007 | .304 | .767 | .373 | .657 |
| | New | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1951–52 | Ottawa | .135 | .065 | .078 | .151 | .765 | .230 | .318 |
| | New | .192 | .185 | .073 | .176 | .320 | .384 | .509 |
| 1952–53 | Ottawa | .118 | .164 | .090 | .213 | .551 | .216 | .446 |
| | New | .177 | .035 | .155 | .285 | .544 | .489 | .505 |
| 1953–54 | Ottawa | .144 | .157 | .060 | .445 | .624 | .343 | .398 |
| | New | .223 | .184 | .098 | .453 | .545 | .316 | .416 |
| Aver. * | Ottawa | .132 | .130 | .076 | .270 | .647 | .263 | .387 |
| | New | .197 | .135 | .109 | .305 | .470 | .396 | .477 |

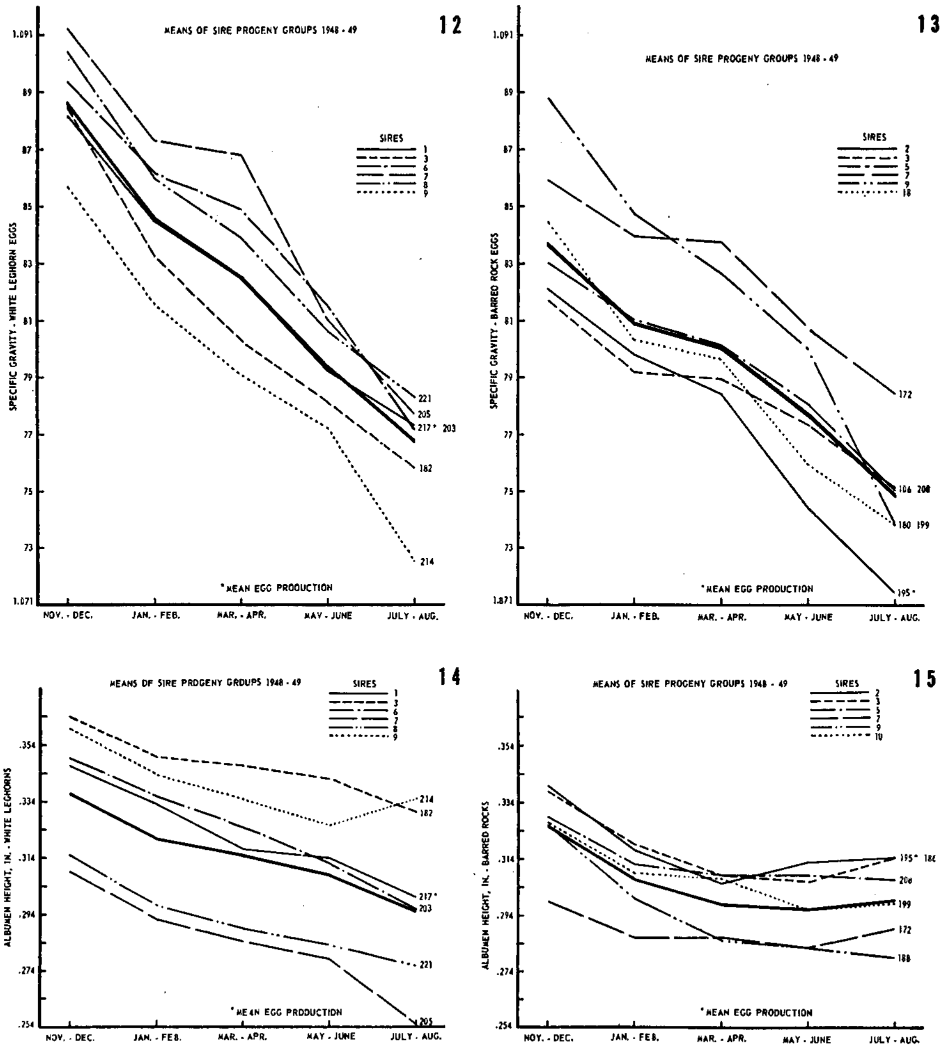
* Based on last three years.

The heritability of traits such as March egg weight and March body weight is relatively high, and selection based simply on individual performance for the most part should result in a satisfactory rate of genetic progress.

The relatively low heritability estimates obtained for the two most important economic traits—egg production and laying house mortality—emphasize the need for selection programs utilizing family performance records when selection is directed at improving these traits.

***Problems in selection for egg quality:*** Three of the important criteria of quality in eggs are, (1) thickness or height of the thick white or firm albumen, as measured on the broken-out egg, (2) strength of shell, which can be estimated by measuring the specific gravity of the egg, and (3) freedom from blood and meat spots. These characteristics contribute to the financial returns of the producer because they affect the grading results and because shell strength is important in avoiding egg breakage before and after marketing.

Figures 12 to 15 show the seasonal decline that occurred in albumen height and specific gravity of fresh eggs from two flocks of laying hens, one of White Leghorns and the other Barred Rocks. These graphs show that the albumen quality of the fresh-laid egg (these eggs were measured within two hours after laying) declines as the season progresses. When this physiological decline coincides with high summer temperatures, as is usually the case, the importance of optimum holding and marketing conditions for maintaining egg quality is emphasized. Some of the eggs measured in this study, particularly in July and August, were actually of B-grade quality when laid. Shell strength also showed a similar seasonal decline which would result in higher egg breakage. The flock means (heavy lines) in the graphs show that shell quality was somewhat lower in the Barred Rocks than in the White Leghorns. On the basis of these results, the most important time of the year at which to evaluate strains of birds for albumen quality and shell strength is in the early summer—about June or July. Any strain deficiencies in these traits should be most apparent at that time.




Figures 12, 13, 14, 15. Seasonal trends in mean specific gravity and albumen height of eggs from a White Leghorn and a Barred Rock flock, showing variation between sire progeny groups. Heavy lines are flock means.

The differences between sire means in Figures 14 and 15 show that groups of hens that are related genetically (full or half-sisters) tend to produce eggs of different albumen quality from other such groups. Heritability estimates obtained for these egg quality traits were as follows: for albumen height, 0.55 for the White Leghorns and 0.17 for the Barred Rocks, averaging 0.36; and for specific gravity the White Leghorn estimate was 0.32, and the Barred Rock estimate was 0.56, averaging 0.44.

This means that, other things being equal, selection for these characteristics should produce a noticeable response in succeeding generations. While there appears to be a marked difference between these two flocks in the heritability of albumen height, it should be emphasized that the actual breed difference in heritability may not be so great, since (1) these estimates may not be representative of all Barred Rock or White Leghorn flocks, (2) the sampling errors of heritability estimates are fairly great.

It has been stated that progress in selection for a given trait can be achieved if heritability is high. This is, however, subject to limitations. In practical poultry breeding, selection is always made for more than one trait. If two traits under selection happen to be negatively correlated genetically, then the progress which is achieved, in relation to the expected gain, will be reduced or nullified. If only one of these traits is under selection there will be a change in the other, in the opposite direction. The extent of this change will depend on, (1) the amount of selection being practised, (2) the size of the correlation between the traits. Conversely, if the genetic correlation is positive, selection for one trait should be accompanied by a positive increase in the other.

This study showed a negative genetic correlation between albumen quality and egg production in the White Leghorns at a level of about −.65. This correlation in the Barred Rocks was either a low negative or positive. The genetic relationship between specific gravity (shell strength) and egg production was positive in the White Leghorns and negative in the Barred Rocks indicating that selection would have had different results in the two flocks.

It appears, therefore, that, if selection for albumen quality is practised, there will be a decrease in egg production level. Conversely, unless there is a compensating factor, selection for increased egg production should result in lower albumen quality. Thus the matter of genetic improvement of egg quality traits in practical breeding appears to be a complex problem. Until further information is available, breeders should, in most cases, put minor emphasis on selection for egg quality and major emphasis on selection for egg production.

Blood or meat spots, when detected by candling eggs at commercial grading stations, will result in the rejection of those eggs and a consequent economic loss to the producer. Colored meat spots are found almost entirely in eggs that have brown shells. White-shelled eggs have white meat spots. The seasonal trend in incidence of all sizes of blood spots in both flocks, and of meat spots in the Barred Rock flock, is indicated in Table 3.

TABLE 3. SEASONAL TREND IN PERCENTAGE INCIDENCE OF BLOOD SPOTS IN WHITE LEGHORNS AND BARRED ROCKS AND MEAT SPOTS IN THE LATTER BREED

| — | Breed | Nov.-Dec. | Jan.-Feb. | Mar.-Apr. | May-June | July-Aug. | Total |
|---|---|---|---|---|---|---|---|
| Blood spots | White Leghorns | 1.9 | 4.7 | 8.1 | 13.8 | 12.5 | 8.3 |
| | Barred Rocks | 2.1 | 3.6 | 5.3 | 8.3 | 5.8 | 5.1 |
| Meat spots | Barred Rocks | 5.8 | 13.9 | 25.0 | 23.8 | 25.2 | 18.9 |

It is noted that both blood and meat spots increased in incidence as the season progressed. The heritability of the incidence of these inclusions was found to be about .22.

One theory regarding the nature of these inclusions has been that colored meat spots are degenerated blood spots. If that were the case, they should occur in about the same proportion in eggs from different families. That this is not so is indicated by the data in Table 4, showing the incidence for two different sire progeny groups of Barred Rocks.

The daughters of Sire 1220 had the lowest incidence of blood spots of any sire progeny group and they had the second highest meat spot incidence. Sire group 1193 had an average incidence of meat spots but was highest in blood spot incidence. It appears that these inclusions are distinctly different entities.

TABLE 4. PERCENTAGES OF BLOOD AND MEAT SPOTS IN TWO SIRE FAMILIES OF BARRED ROCKS

| Sire | | Nov.-Dec. | Jan.-Feb. | Mar.-Apr. | May-June | July-Aug. | Total |
|---|---|---|---|---|---|---|---|
| 1220 | Blood spots | 1.2 | 1.4 | 1.8 | 2.2 | 2.4 | 1.8 |
| | Meat spots | 9.5 | 17.7 | 50.9 | 36.0 | 35.3 | 30.4 |
| 1193 | Blood spots | 1.8 | 4.9 | 11.3 | 10.6 | 7.3 | 7.3 |
| | Meat spots | 5.2 | 11.5 | 22.1 | 24.0 | 29.1 | 18.0 |

***Improvement of the Broad Breasted White breed of meat chicken:*** In 1950, a project was undertaken on the breeding of chickens, specifically for meat production, with the combined object of studying the inheritance of meat production traits as well as of developing a breed or breeds that would be acceptable for meat production.

The Broad Breasted White, a breed that was developed at the Poultry Division at Ottawa, was used for this study. This breed was used in order to take advantage of its desirable traits that could be utilized in a crossbreeding program. The Broad Breasted White carried the dominant genetic factor for white feathering and, as it originated in part from the Cornish breed, it had exceptional width of breast.

In 1950, the original population was increased in size, and in 1951, 1952, and 1953, the breed was crossed with other heavy meat breeds in order to determine the importance of heterosis for meat production traits and also to test its combining ability with other pure breeds developed for meat production. Branch Farms at Lethbridge and Charlottetown co-operated in these studies.

One of the chief difficulties encountered in using the Cornish breed, or a breed of Cornish origin such as the Ottawa Broad Breasted White, is the very low level of fertility that is generally characteristic of the Cornish breed. The fertility and hatchability results of the Broad Breasted Whites, other meat production strains tested in this project, and the cross-mating of Broad Breasted Whites with these meat strains is shown in Table 5 for the 3 years 1951 to 1953. The fertility level in the cross-matings was slightly higher than in the pure Broad Breasted Whites. The hatchability of the crosses was slightly better over the three-year period than for the better parent (the other meat strains). Although various breeding techniques, including insemination, have been employed to improve the fertility in the Broad Breasted Whites, this strain still remains very undesirable in this respect.

TABLE 5. A COMPARISON OF THE FERTILITY AND HATCHABILITY OF THE BROAD BREASTED WHITE BREED WITH THE AVERAGE OF OTHER MEAT STRAINS AND THE CROSS MATINGS.

| — | Fertility (%) | | | Hatchability (%) | | |
|---|---|---|---|---|---|---|
| | 1951 | 1952 | 1953 | 1951 | 1952 | 1953 |
| Broad Breasted White | 43 | 56 | 50 | 75 | 77 | 82 |
| Other strains | 93 | 87 | 88 | 91 | 86 | 88 |
| B.B. White males × other strains females | 81 | 59 | 67 | 89 | 87 | 90 |

A comparison of the Broad Breasted White with other meat strains and of crosses between Broad Breasted White and these other strains for various meat production traits is presented in Table 6. The Broad Breasted Whites have relatively small body weight, but have very superior breast width. The crosses were slightly below the average of the pure strains in body weight but intermediate to the Broad Breasted White and the other strains in breast width. Both breast blisters and crooked keels are undesirable in market poultry as they detract from the appearance of the dressed carcass. The crosses had a slightly higher percentage of breast blisters but were intermediate in percentage of crooked keels.

TABLE 6. A COMPARISON OF VARIOUS MEAT PRODUCTION TRAITS, AT 12 WEEKS OF AGE, OF THE BROAD BREASTED WHITE WITH THE AVERAGE OF OTHER MEAT STRAINS AND THE CROSSBREDS. DATA FOR 2 YEARS AND FOR 3 FARMS—MALES AND FEMALES COMBINED.

| — | Body weight | Breast width | Keel length | Shank length | Breast blisters | Crooked keels |
|---|---|---|---|---|---|---|
| | gm. | cm. | cm. | cm. | % | % |
| Broad Breasted White | 1346 | 2.46 | 9.22 | 9.62 | 3.8 | 4.3 |
| Other strains | 1670 | 2.32 | 10.43 | 11.24 | 3.0 | 11.4 |
| Broad Breasted White crosses | 1603 | 2.39 | 10.07 | 11.09 | 5.2 | 7.2 |

Figure 16 shows the effect of cross-breeding on the various body measurements and on egg production. The percentage increase of the crossbreds over the mid-parental value (the average of the two pure breeds used to make the cross) for a given trait is a measure of heterosis. As seen in Figure 16, the greatest improvement was in the egg production of the crossbreds on both a hen-housed and a survivor basis. All body measurements other than breast width and breast angle showed some improvement over the mid-parental value.

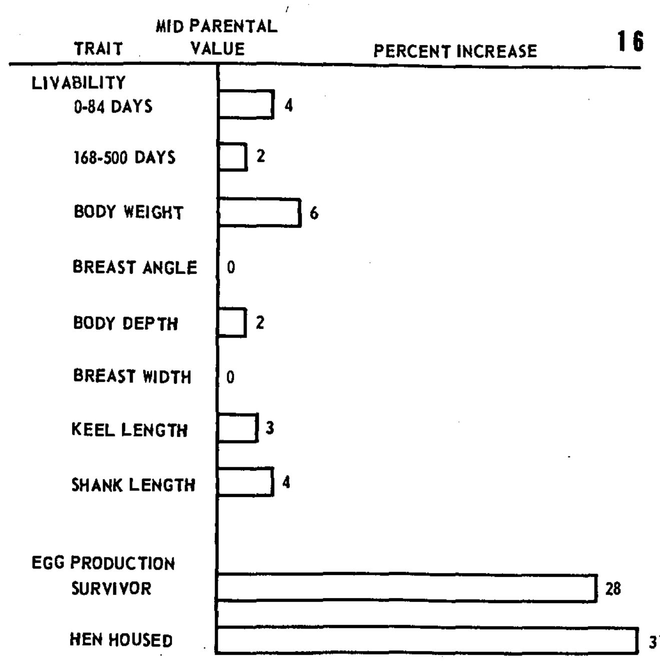



Figure 16. Heterosis for various traits and body measurements in meat production birds as measured by the percentage increase of the progeny over the mid-parental value.

The percentages of the different market grades for the Broad Breasted White, as compared with the other meat strains and crosses, are shown in Table 7. All birds were graded on the four factors, conformation, fleshing, fat, and dressing, by an inspector of the Marketing Service. The grading percentages as shown in the table were based on the conformation and fleshing factors only. The Broad Breasted Whites graded very high, 77.8 per cent of the birds grading special, as opposed to only 33.4 per cent of the birds of the other meat strains; 54.6 per cent of the crossbreds graded special.

TABLE 7. PERCENTAGES OF DIFFERENT MARKET GRADES FOR BROAD BREASTED WHITES AS COMPARED WITH THE OTHER MEAT STRAINS AND CROSSBREDS. DATA FOR 2 YEARS—MALES AND FEMALES COMBINED.

| Strain | Grades | | |
|---|---|---|---|
| | Special | A | Combined B and C |
| Broad Breasted White | 77.8 | 19.8 | 2.4 |
| Other meat strains | 33.4 | 52.8 | 13.8 |
| Broad Breasted White crossbreds | 54.6 | 41.2 | 4.2 |

***Value of body measurements in breeding poultry for meat production:*** The value of body measurements in differentiating between commercial market grades in poultry is illustrated in Table 8. It is apparent that differences exist between the two grades for most of the body measurements. Breast angle and breast width were both higher for the Grade 1 birds while all the other measurements, with the exception of 6-week body weight, for females, were lower for the Grade 1 birds. Other data analyzed over a period of years have given the same results as illustrated in this table. There is one exception, however, in that body weight differences are not always in favor of either one grade or the other. Even in this table, the body weight differences are not great. Statistical analysis of these data shows that body measurements are important in differentiating between grades, and, therefore, would be of some importance in breeding for carcass quality as measured by market grades.

TABLE 8. MEANS OF SEVERAL BODY MEASUREMENTS OF MALES AND FEMALES, SEPARATED AS TO MARKET GRADE. DATA FOR BROAD BREASTED WHITES, UNWEIGHTED MEANS FOR 2 HATCHES AT 3 FARMS.

| Sex | Grade | Number of individuals | 6 week weight gm. | 12 week weight gm. | Breast angle deg. | Body depth cm. | Breast width cm. | Keel length cm. | Shank length cm. |
|---|---|---|---|---|---|---|---|---|---|
| Males | 1 | 212 | 531 | 1474 | 81.8 | 9.2 | 2.51 | 9.6 | 10.7 |
| | 2 | 68 | 546 | 1515 | 76.8 | 9.5 | 2.41 | 9.9 | 11.2 |
| Females | 1 | 307 | 474 | 1184 | 82.7 | 8.6 | 2.44 | 8.9 | 9.0 |
| | 2 | 44 | 472 | 1199 | 78.5 | 8.8 | 2.27 | 9.1 | 10.0 |

Body measurements may be of value also in selecting and breeding birds for superior yield of edible meat. A number of different measurements were taken with various instruments, and the values correlated with the amount of breast meat on the bird. The correlations obtained are shown in Table 9. It is apparent that some measurements are not very highly correlated with breast meat yield; therefore, they would be of limited value. In almost every case, the measurements taken on dressed birds had a higher correlation than the same measurements taken on live birds. Statistical analysis of the data has shown that other body measurements taken with body weight give a greater accuracy in evaluating meat yield than body weight alone.

TABLE 9. CORRELATION COEFFICIENTS BETWEEN VARIOUS BODY MEASUREMENTS AND BREAST MEAT YIELD USING DIFFERENT INSTRUMENTS ON BOTH LIVE AND DRESSED BIRDS.

| Measurement | Live birds | | Dressed birds | |
|---|---|---|---|---|
| | M | F | M | F |
| Body weight, 6 wk | .79 | .74 | .......... | .......... |
| Body weight, 12 wk | .91 | .86 | .93 | .......... |
| Body depth | .61 | .37 | .53 | .50 |
| Breast width (1) | .51 | .24 | .72 | .38 |
| Breast angle (2) | .46 | .37 | .67 | .32 |
| Breast angle (3) | .75 | .31 | .74 | .45 |
| Breast width (4) | .22 | .25 | .56 | .42 |
| Breast width (5) | .......... | .......... | .63 | .42 |
| Keel length | .......... | .......... | .86 | .71 |
| Shank length | .......... | .......... | .79 | .48 |

(1) Bird's instrument. (2) West Virginia Angle meter. (3) Modified West Virginia Angle meter. (4) Solder wire method. (5) Production Service instrument.

The problem of finding suitable instruments and developing techniques of taking body measurements (especially breast measurements), so that they would be of value to the poultry breeder, is a difficult one. Various instruments and techniques have been tried, and some of those used in the studies presented in this report have been further tested for their accuracy. This was done by taking repeat measurements on the same birds, with the same operator doing the measuring; the results are presented in Table 10.

TABLE 10. CORRELATION COEFFICIENTS BETWEEN REPEAT MEASUREMENTS OF THE SAME BIRDS WITH DIFFERENT INSTRUMENTS

| Measurement | Live birds | | Dressed birds | |
|---|---|---|---|---|
| | M | F | M | F |
| Body depth | .75 | .81 | .83 | .94 |
| Breast width (1) | —.13 | .34 | .56 | .74 |
| Breast angle (2) | .78 | .88 | .59 | .75 |
| Breast angle (3) | .71 | .90 | .82 | .87 |

(1) Bird's instrument. (2) West Virginia Angle meter. (3) Modified West Virginia Angle meter.

The closer these values are to 1.0, the more accurate is the technique. It can be seen that some instruments have a very low repeatability or accuracy, and this would be a definite limitation in recommendations as to their general use. Of the breast width measuring instruments tested, it appears that the one designed to measure breast angle has the greatest utility in broilers.

***Selecting for increased reproductive ability in geese:*** With the increasing interest being shown in recent years in the goose as a meat bird, especially as a bird that can obtain a large percentage of its food from pastures, work was initiated at Ottawa in 1951 with a flock of Pilgrim geese, to study the problems associated with the breeding of geese and to see if the reproductive performance as well as the growth rate could be improved by selection.

Trapnests were employed to measure individual egg production and also to obtain pedigree data for selection and genetic information. Only one other study has been reported on the use of trapnests for geese but none has been reported in which trapnest records and pedigree information have been employed for purposes of selection and improvement.

Table 11 shows the egg production of the Ottawa strain of Pilgrim geese from 1950 to 1954. The flock average for 1950 was 14 eggs, and this has shown a steady rise each year to 29 eggs in 1954. The average of the pullet flock (geese in their first year of production) has increased from 17 eggs in 1951 to 26 eggs in 1954.

TABLE 11. EGG PRODUCTION OF THE OTTAWA STRAIN OF PILGRIM GEESE, 1950–1954

| Year | Total numbers in flock | | | | | | Egg production of total flock*** | | | Egg production of "pullet" geese only | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I.M.* | | F.M.* | | All birds | | I.M. | F.M. | All birds | Females | Egg prod. | Stan. dev. | Range |
| | M. No. | F. No. | M. No. | F. No. | M. No. | F. No. | No. | No. | No. | No. | No. | No. | No. |
| 1950 | 2 | 4** | ...... | ...... | 2 | 4 | 14 | ...... | 14 | ...... | ...... | ...... | ...... |
| 1951 | 6 | 18 | ...... | ...... | 6 | 18 | 18 | ...... | 18 | 14 | 17 | 8.2 | 3–38 |
| 1952 | 16 | 64 | ...... | ...... | 16 | 64 | 20 | ...... | 20 | 45 | 20 | 8.3 | 2–44 |
| 1953 | 16 | 80 | 14 | 70 | 30 | 150 | 28 | 19 | 24 | 119 | 22 | 9.8 | 1–59 |
| 1954 | 16 | 80 | 14 | 70 | 30 | 150 | 31 | 27 | 29 | 110 | 26 | 9.3 | 0–51 |

*—I.M.—Individual male matings. Females trapped every year but 1950.
F.M.—Flock-matings—2 flock-matings each with 7 males and 35 females.

**—One male and one female were from outside stock and as far as can be determined they were unrelated to the original stock.

***—Floor eggs included for all years.

Table 12 shows the effect of age on the egg production of geese. Although the data for birds laying to their fourth year are somewhat limited, the table does show that the egg production of geese does increase with age, a very important consideration for anyone intending to produce day-old goslings commercially.

TABLE 12. EFFECT OF AGE ON EGG PRODUCTION IN PILGRIM GEESE

| Years in production No. | Females No. | Mean egg production | | | |
|---|---|---|---|---|---|
| | | First year No. | Second year No. | Third year No. | Fourth year No. |
| 4 | 5 | 23 | 24 | 26 | 28 |
| 3 | 21 | 24 | 29 | 35 | ........... |
| 2 | 56 | 26 | 30 | ........... | ........... |

The fertility and hatchability of the Ottawa strain of Pilgrim geese is shown in Table 13, for the years 1950 to 1954. Although the fertility and hatchability were higher in 1950 than in subsequent years, these estimates are based on a very small number of birds. However, it will be seen from the table that there has been a gradual improvement in the flock average from 1951 to 1954.

TABLE 13. FERTILITY AND HATCHABILITY OF THE OTTAWA STRAIN OF PILGRIM GEESE, 1950-1954

| Year | Females per male No. | Mated females | | Fertility | | | Hatchability | | |
|---|---|---|---|---|---|---|---|---|---|
| | | old No. | young No. | I.M.* % | F.M.* % | All birds % | I.M. % | F.M. % | All birds % |
| 1950 | 2 | 2 | 2 | 88 | ........ | 88 | 81 | ........ | 81 |
| 1951 | 3 | 4 | 14 | 66 | ........ | 66 | 71 | ........ | 71 |
| 1952 | 4 | 19 | 43 | 71 | ........ | 71 | 71 | ........ | 71 |
| 1953 | 5 | 31 | 119 | 74 | 81 | 77 | 77 | 70 | 75 |
| 1954 | 5 | 40 | 110 | 80 | 70 | 76 | 79 | 64 | 73 |

*—I. M.—Individual male matings. Females trapped every year but 1950.
F.M.—Flock-matings—mean of 2 flock-matings each with 7 males and 35 females.

The body weights attained at 16 weeks for 1951 and 1952 and at both 10 and 16 weeks for 1953 and 1954 are shown in Table 14. These birds were reared on pasture on a restricted feeding program after 4 to 6 weeks of age. These figures show the rather remarkable growth rate of geese even when the chief source of their diet is pasture.

TABLE 14. BODY WEIGHTS OF YOUNG PILGRIM GEESE REARED ON PASTURE AND ON RESTRICTED FEED 1951-1954

| Year | Birds alive at 16 wk. | | 10 wk. wt. | | 16 wk. wt. | |
|---|---|---|---|---|---|---|
| | Males | Females | Males | Females | Males | Females |
| | No. | No. | lb. | lb. | lb. | lb. |
| 1951 | 40 | 45 | ........... | ........... | 10.1 | 8.7 |
| 1952 | 90 | 112 | ........... | ........... | 10.0 | 8.5 |
| 1953 | 284 | 356 | 8.5 | 7.3 | 10.3 | 8.8 |
| 1954 | 379 | 348 | 9.2 | 7.9 | 11.0 | 9.3 |

***Effect on subsequent egg production, of vaccinating laying hens of several strains and age groups with turkey pox vaccine:*** On November 7, 1952, when housing two groups of birds (White Rocks and New Hampshires—G House; see Figure 17), it was observed that they showed the typical symptoms of fowl pox (comb and face scabs in particular) although they were in good condition and obviously had almost recovered from a mild attack of this disease on range. As a precaution against spread of the fowl pox to all of the other birds on the plant, all the stock was vaccinated on November 18, 19 and 20 with turkey pox vaccine, to build up the immunity to the more virulent fowl pox. None of the birds on the plant had been vaccinated for fowl pox previously.

There were considerable differences between groups of birds in their response to the vaccination. The data for each group of birds in the various houses is graphically presented in Figures 17 and 18.

The two groups of birds originally showing symptoms of fowl pox were apparently not affected by the vaccination with the turkey pox vaccine (Figure 17).

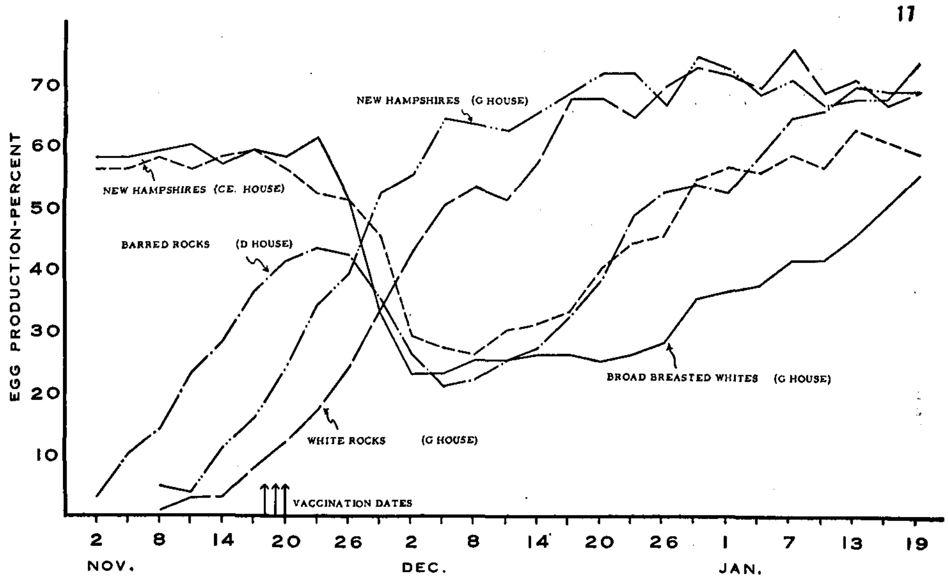



Figure 17. The effect on egg production of vaccinating several groups of birds with turkey-pox vaccine. The New Hampshire and White Rocks (G House) had contracted fowl pox on range and were not affected by the vaccination.

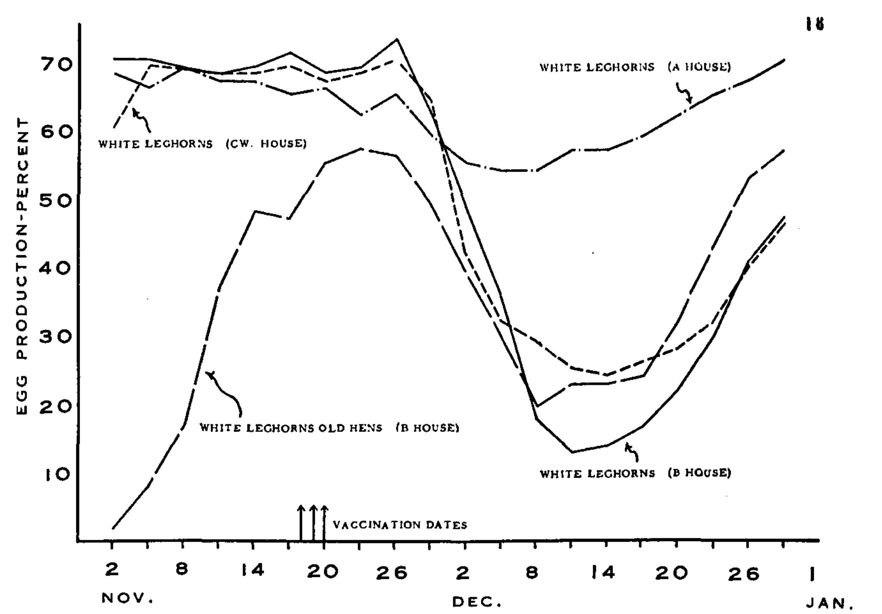



Figure 18. The effect on egg production of vaccinating several groups of Leghorns with turkey-pox vaccine. The management in A House was apparently responsible for the slight decline and rapid recovery of this group of birds.

The New Hampshire (*C.E. House*) and the Broad Breasted Whites (*G House*) were housed on September 12 and September 26, respectively; they had been laying at 60 per cent for several weeks prior to the vaccination. Six days after the vaccination, production dropped rapidly and in 12 days production had reached a low of about 30 per cent, after which it gradually recovered over the following two months. The Barred Rocks (*D House*) were housed on October 24 at 160 days of age and they had reached about 40 per cent production at the time of the vaccination. Production dropped about 20 per cent but recovered rapidly for these relatively low-producing strains.

There was some evidence that management of the birds played some role in determining the severity of the post-vaccination effects (Figure 18). White Leghorns in the C House were housed on August 5 and 19 at 160 days of age and after vaccination, they dropped to about 25 per cent production and slowly recovered. The pullet Leghorns in the B House were all housed on September 27 (160 days of age) and production dropped from over 70 per cent to about 15 per cent with a fairly rapid recovery. The A House birds were housed September 9 at 160 days of age and dropped only about 15 per cent in production to 55 per cent and recovered rapidly. In this instance, the birds were in small pens; perhaps the better management may have been responsible for keeping the birds from falling too low in production.

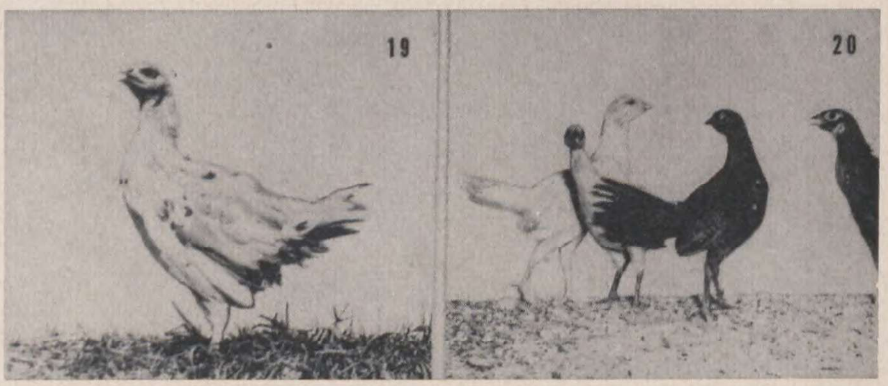
It would appear that (1) a fowl-pox vaccination program prior to the beginning of egg production is highly important commercially, particularly if fowl pox is present in the vicinity and there is a chance of exposure; (2) if birds have to be vaccinated after they are in production, every attempt should be made to do this as soon as possible and to provide the birds with good management. Maintaining feed consumption and keeping the birds comfortable are probably important in this regard.

***Hybridization of the Chinese Ringneck pheasant and the domestic fowl:*** There are numerous references in the literature to the crossing of chickens and pheasants. Most of these reports state that the hybrids were sterile; however, some indicated that fertile hybrids have been produced. One commercial concern on this continent claims to have produced and marketed meat birds that were the result of crossing chickens and pheasants, the hybrids having been back-crossed for four generations to domestic fowl to provide the market birds.

Preliminary studies at Ottawa in 1951 showed that pheasants crossed better with Old English Games than with other breeds of chickens. This was based on the use of artificial insemination. In 1952, an experiment was set up in which standard doses of pooled semen from pheasant cocks were inseminated into chicken females of 5 different breeds and crosses, including Old English Games. The results are briefly summarized in Table 15. Here, also, better results were obtained by crossing the pheasants with the Old English Games than with the other breeds tested. This difference in the ability of pheasants to cross with various breeds of domestic fowl may explain varying reports in the literature on the fertility and hatchability resulting when pheasants and chickens are crossed.

All the hybrids were kept alive for at least 12 months. In all cases, the male hybrids never produced semen (some were maintained for over 36 months). The female-like hybrids never produced eggs and on autopsy both sexes had only rudimentary gonads and sex organs. In one female-like hybrid, a careful autopsy revealed no evidence of a gonad or any secondary sex organs.

Hybrids which had one parent carrying the dominant white (color inhibiting factor) in chickens were mainly white feathered with a few colored feathers (Figure 19). Crosses between the Old English Games and the pheasants had feather colors similar to the wild-type female pattern of the Jungle Fowl. Hybrids from both Broad Breasted White (dominant white) and Old English Game female parents are illustrated in Figure 20.




Figures 19 and 20. Pheasant male × chicken females hybrids. The white birds with black flecks were hatched from eggs laid by chickens homozygous for dominant white. Note the lack of a comb and the feathers with chicken and pheasant characteristics.

TABLE 15. NUMBERS OF HYBRIDS (PHEASANT MALE × CHICKEN FEMALES) PRODUCED FROM FIVE GROUPS OF FEMALES EACH INSEMINATED WITH A SINGLE DOSE OF 0.05 ML. OF POOLED CHINESE RINGNECK PHEASANT SEMEN (1952).

| Breed of female | Females inseminated No.* | Hatchability of fertile eggs | | Hybrid chicks hatched No. |
|---|---|---|---|---|
| | | No. | % | |
| Old English Games | 15 | 32 | 50.0 | 16 |
| Broad Breasted Whites | 15 | 21 | 9.5 | 2 |
| New Hampshire | 14 | 20 | 20.0 | 4 |
| Old English Games × Broad Breasted Whites | 10 | 21 | 9.5 | 2 |
| Broad Breasted Whites × Old English Games | 9 | 17 | 11.8 | 2 |
| Total | 63 | 111 | 23.4 | 26 |

## Physiology of Reproduction

***Studies of a genetically determined type of infertility in the fowl:*** Normal fertility in birds is dependent upon a complex chain of events that must occur in proper sequence and must be of the appropriate qualitative and quantitative character. Any deviation from normal of any part of this process either in the amount or the quality of the reaction could lead to a reduction of the fertility of the birds in question; if it is a severe enough deviation from the normal, sterility could result. It can be seen that the possible causes of infertility are very numerous. The Broad Breasted White—a breed developed at the Central Experimental Farm—characteristically has lower fertility than other breeds. It was thought that useful information on the general problem of infertility might come from an investigation as to the causes of low fertility in this breed.

A fertile strain of S.C. White Leghorns was used as the control breed in these studies. A series of experiments was run to compare the duration of fertility of semen from cocks of the two breeds. At the same time, laboratory tests on the "quality" of the semen were made. Reciprocal crosses between the two breeds were made and the crossbred males ($F_1$ males) were compared with the pure breeds as to duration of fertility in the following year.

These series of experiments demonstrated conclusively that the infertility of the Broad Breasted Whites was genetically determined. The $F_1$ reciprocal crosses were approximately intermediate between the two breeds in fertility, which suggested that the infertility was determined by autosomal gene(s) that were not dominant in action (Figure 21).

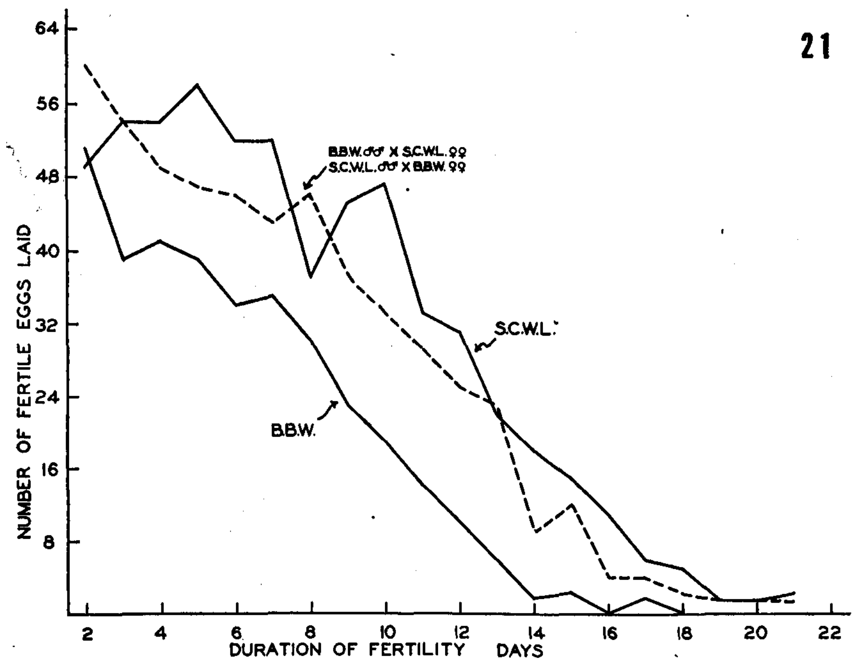



Figure 21. Duration of fertility of semen from males of a relatively fertile breed (S.C.W.L.) and a relatively infertile breed (B.B.W.) and F1 crosses of these two breeds.

Although the motility of the spermatozoa of the Broad Breasted White males was significantly lower than that of the S.C. White Leghorn males, the correlation between the laboratory motility reading and the actual fertility records was not high. No predictions could be made as to the fertility of individual males, on the basis of motility readings, except in extreme cases. The relatively infertile breed produced semen with as great a density of spermatozoa per unit volume as the fertile breed. The low fertility of the Broad Breasted Whites was not caused by deficiences in numbers of spermatozoa or in volume of semen.

A different staining technique was used to differentiate live from dead spermatozoa. The results were closely correlated with those for initial motility which indicated that the movement of spermatozoa differentiates the living from the dead cells, for most practical purposes.

***Relationship between dose of semen and the duration of fertility following single inseminations:*** A series of experiments was designed to explore the relationship between dosage of semen and the duration of fertility (measured as the number of days from the date of artificial insemination till the date the hen lays the last fertile egg). This basic information was required prior to investigating the cause of the differences among breeds and strains in level of fertility. Several breeds were used in these studies to see if breed differences in the duration of fertility could be found.

The study of fertility requires special procedures since the fertility of an egg is obviously a combined phenotypic expression of the male that produced the semen and of the female that produced the egg. The hen's phenotype determines whether the spermatozoa can survive and emigrate readily in the oviducal fluids and whether the ovum is "fertilizable". The phenotype of the male determines the quality of the spermatozoa produced. Since either the male or the female can influence the fertility, it was important to estimate the contribution of each by appropriate techniques.

In earlier studies, it has been shown that the duration of fertility following a single insemination is a useful tool for measuring, quantitatively, the male and female role in fertility.

The results of the first experiment utilizing White Leghorns and Barred Rocks, are summarized in Table 16. The differences in fertility due to various doses were small and insignificant. There was a significant breed difference; the White Leghorn males had the longer duration of fertility following a single insemination. A significant interaction between males and females of the two breeds was shown. Spermatozoa from White Leghorn males lived for longer periods in the oviducts of females of the same breed than in the oviducts of females of the other breed and the same phenomenon was true with respect to the Barred Rock semen. This may have some practical importance with regard to the extensive use of crossbreeding by commercial hatcherymen.

TABLE 16. DURATION OF FERTILITY IN RECIPROCAL MATINGS OF BARRED ROCKS AND WHITE LEGHORNS USING 4 DIFFERENT DOSES OF SEMEN

| Dose of semen | Barred Rock males | | White Leghorn males | | Combined breeds days |
|---|---|---|---|---|---|
| | White Leghorn females days | Barred Rock females days | White Leghorn females days | Barred Rock females days | |
| .05 ml. | 11.2* | 10.5 | 15.5 | 12.5 | 12.4 |
| .10 ml. | 15.8 | 12.2 | 15.0 | 12.5 | 13.9 |
| .15 ml. | 9.2 | 13.5 | 14.5 | 15.2 | 13.1 |
| .20 ml. | 11.5 | 14.8 | 15.5 | 12.5 | 13.6 |
| Combined doses | 11.9 | 12.8 | 15.1 | 13.2 | 13.2 |
| | 12.3 | | 14.2 | | |

* Mean of 4 females per sub-group.

Since the lower limit in dosage level had not been reached in the above experiment, another experiment was set up, using doses ranging from 0.05 ml. to 0.01 ml. Special pipettes were designed for these tests to accurately deliver doses as small as 0.01 ml. In this experiment, semen from two breeds of males (nine unrelated males in each case) was used. A total of 90 White Leghorn females was used. Eighteen females were inseminated with each level of dosage of semen. Males of a very fertile breed (White Leghorn) and a relatively infertile breed (Broad Breasted White) were used for these studies. It was thought that there might be different dosage requirements for optimum fertility in the two breeds.

There was a striking breed difference in the duration of fertility as may be seen in Table 17. The Broad Breasted White males produced spermatozoa that could live for only 1.9 days, on the average, in the oviducts of White Leghorn females. Increasing the dose apparently did not increase the duration of fertility for this breed or for the White Leghorns. This study took place in May and June when fertility was declining for all breeds.

TABLE 17. DURATION OF FERTILITY IN WHITE LEGHORN FEMALES WHEN INSEMINATED WITH DIFFERENT DOSES OF SEMEN FROM WHITE LEGHORN AND BROAD BREASTED WHITE MALES.

| Dose of semen | White Leghorn male semen | Broad Breasted White male semen | Combined breeds |
|---|---|---|---|
| | Mean duration of fertility days | Mean duration of fertility days | Mean duration of fertility days |
| .05 ml. | 5.9 | 1.9 | 3.9 |
| .04 ml. | 8.0 | 3.1 | 5.6 |
| .03 ml. | 7.2 | 1.9 | 4.6 |
| .02 ml. | 5.4 | 1.1 | 3.3 |
| .01 ml. | 7.3 | 1.6 | 4.4 |
| Combined doses | 6.8 | 1.9 | 4.3 |

Increasing the dosage at this season did not overcome the apparent seasonal decline in fertility for either the relatively fertile breed or the infertile one. Although artificial insemination has not been used by the practical chicken breeder to any significant extent, this technique could be of value to the specialized breeder. By using small doses of semen of the order of 0.01 ml., a breeder could inseminate 50 to 75 hens from a single ejaculation of a proved cock and since the males could be ejaculated daily and the hens inseminated twice weekly, one male could be mated to 150 to 200 hens, using artificial insemination and could potentially produce from 2,000 to 4,000 progeny in a single season.

***Effect of the addition of L-thyroxine to fowl semen:*** Experiments were designed to see if thyroxine would have any effect on duration of fertility of females using semen from both a relatively infertile breed (Broad Breasted White) and a relatively fertile breed (S.C. White Leghorn) and to see if subsequent hatchability of the zygotes developing from the treated spermatozoa would be affected.

Two experiments were conducted. The results are combined and presented in Table 18. The difference between treatments was not statistically significant although the thyroxine-treated semen gave a shorter duration of fertility by one day.

The hatchability of eggs fertilized by treated spermatozoa was not improved significantly when White Leghorn semen was used, but there was a 10 per cent improvement for the semen from the relatively infertile Broad Breasted Whites. The data are presented in two ways, (1) each hen receiving equal weight and (2) each egg receiving equal weight. The results are essentially similar. It is suggested, as a result of these experiments, that the addition of thyroxine to the semen from the infertile males used in this study increased the hatchability of the resulting zygotes by overcoming a basic thyroid deficiency in the Broad Breasted Whites. More extensive data would be desirable. It may be possible to improve the hatchability of some infertile breeds by thyroid treatment.

TABLE 18. DURATION OF FERTILITY AND THE HATCHABILITY OF FERTILE EGGS FOLLOWING ARTIFICIAL INSEMINATION WITH 0.2 ML. OF THYROXINE-TREATED AND UNTREATED SEMEN.

| Group | Breed | Females No. | Mean duration of fertility Days | Females No. | Hatchability of fertile eggs 1* % | Hatchability of fertile eggs 2* % |
|---|---|---|---|---|---|---|
| Thyroxine treated | Fertile | 30 | 14.4 | 30 | 78.9 | 80.2 |
| | Infertile | 30 | 9.5 | 27 | 77.3 | 77.9 |
| | Total | 60 | 12.0 | 57 | 78.1 | 79.3 |
| Control | Fertile | 30 | 15.4 | 29 | 82.9 | 84.3 |
| | Infertile | 30 | 10.5 | 30 | 66.1 | 69.8 |
| | Total | 60 | 13.0 | 59 | 74.4 | 78.4 |
| Combined groups and breeds | | 120 | 12.4 | 116 | 76.2 | 78.8 |

* 1. Each hen receiving equal weight. 2. Each egg receiving equal weight.

***Duration of fertility in turkeys:*** Fertility is one of the major problems in turkey breeding. Low fertility may be due to physical incompatibility or to physiological causes. Breeds or strains may vary in the expression of a particular physiological trait such as, for example, duration of fertility. In an experiment to test this hypothesis, turkey hens of two different varieties, Broad Breasted Bronze and Whites (a small to medium-sized turkey) were inseminated with semen from males of the same breed.

A standard technique of insemination was followed and each hen received a single dose of .02 ml. of semen. Duration of fertility was measured in days, from the time of insemination to the day of the last fertile egg. Insemination was done in two periods—one in March and the other in May, after fertility had run out in the first period.

Results of the test showed that there was no appreciable difference in the duration of fertility of the two breeds. The mean fertility durations are given in Table 19.

TABLE 19. MEAN FERTILITY DURATION IN TWO BREEDS OF TURKEYS FROM A SINGLE INSEMINATION IN MARCH AND MAY, RESPECTIVELY

| Breed | March | May |
|---|---|---|
| | No. of days | |
| Broad Breasted Bronze | 38 | 27 |
| Whites | 40 | 31 |
| Mean | 39 | 29 |

The figures show a significant seasonal decline in duration of fertility. This decline is undoubtedly a factor contributing to some of the late-season infertility which is encountered in the field. The standard deviations of the seasonal averages are 15.6 for March and 12.1 for May, respectively. This means that, with respect to duration of fertility, two-thirds of the birds fell within a range which was one standard deviation on either side of the mean or average. Therefore, in March, one-sixth of the turkey hens would be expected to have a fertile period following insemination of 23.4 days or less, whereas in May, the same proportion would be expected to remain fertile for only 16.9 days or less. Therefore, unless the frequency of insemination, either by natural mating or by artificial insemination, were increased in the late season, the percentage of fertile eggs produced would decrease.

***Artificial insemination of geese:*** Artificial insemination has proved to be a useful technique in chicken and turkey breeding. With the former, it has been of greatest value in research work, while it is of definite practical economic importance in raising the fertility level of turkey breeding flocks. No successful technique for artificial insemination of geese had been reported prior to its investigation at the Poultry Division. This is probably due to anatomical differences between geese and the other two species.

Ganders can be trained to respond to the treatment involved in obtaining semen. When the bird is held on the operator's lap, the back and abdomen are stroked and the pubic bones are massaged lightly. This will result in extrusion of the penis and ejaculation. The semen is collected in a suitable glass receptacle, such as a large test tube. The females are inseminated by locating the oviduct opening by palpation through the vent, and inserting a glass tube attached to the insemination syringe into the oviduct, after which the dose of semen is administered.

The technique was developed to the point where it was quite successful. Preliminary results suggest that the average duration of fertility of geese is at least 10 days.

A difference between geese and chickens and turkeys was observed, in that, on the average, 3.6 days passed after the time of insemination before a fertile egg was produced, whereas in the latter two species, fertility is well established on the second day after insemination. This needs to be borne in mind when inseminating or mating up geese for the production of fertile eggs.

## NUTRITION UNIT

*J. R. Aitken (Head), W. G. Hunsaker, G. S. Lindblad, A. B. Morrison.*

### Broiler Rations

The general purpose of an extended series of experiments on broiler rations has been to decrease the cost of the diets while maintaining or improving growth rate and efficiency of feed conversion. Among the problems that have been investigated under this program are the following: (1) Wheat versus corn in broiler rations; (2) The value of barley in broiler rations; (3) Pellets versus mash for broilers; (4) Minimum protein requirements for broilers at various ages; (5) The addition of animal fat to broiler rations.

***Wheat versus corn in broiler rations:*** Corn and wheat are the favored grains for broiler rations, because they are high in energy and low in fiber. Corn is somewhat superior to wheat in these respects, but in Canada it is a more expensive grain than wheat. Accordingly, four experiments were conducted to compare corn and wheat and various mixtures of corn and wheat in broiler rations.

The results of these four tests are shown in Table 20. Body weights for the males only are shown. In two of the tests the birds were graded for finish by a government grader. Some of the rations differed in other respects than the proportions of corn and wheat, but these differences were of such a nature as not to prejudice the corn-wheat comparisons.

It may be observed that in two out of three cases body weights on all corn diets were slightly superior to those on diets containing equal parts of corn and wheat. In the third case a corn-wheat ration was slightly superior to an all-corn diet. In this latter instance the birds were reared during the hot summer months, and it was also observed that feathering was much better on the corn-wheat diet than on the all-corn diet. Feathering was scored both on the live birds and on the dressed carcasses as indicated by the prevalence of pin feathers.

High corn diets tended to promote slightly better feed efficiency and finish. However, the differences in all these characteristics were very slight

TABLE 20. GROWTH, FEED EFFICIENCY AND FINISH ON BROILER RATIONS CONTAINING DIFFERENT AMOUNTS OF CORN AND WHEAT

| Experiment No. | Corn: wheat ratio | Birds No. | Mean body weight lb. | Feed/gain | Grade A finish (%) |
|---|---|---|---|---|---|
| 1 | All corn | 71 | 4.0 | 3.3 | 88 |
| | ½ corn ½ wheat | 78 | 3.9 | 3.1 | 59 |
| | All wheat | 75 | 3.9 | 3.1 | 77 |
| 2 | All corn | 74 | 4.4 | 2.9 | |
| | ½ corn ½ wheat | 86 | 4.5 | 2.9 | |
| | ½ corn ½ wheat | 70 | 4.4 | 3.1 | |
| 3 | All corn | 55 | 4.4 | 3.2 | 96 |
| | ½ corn ½ wheat | 66 | 4.2 | 3.3 | 79 |
| | ½ corn ½ wheat | 64 | 4.3 | 3.4 | 78 |
| 4 | ½ corn ½ wheat | 82 | 4.2 | 3.3 | |
| | ½ corn ½ wheat | 82 | 4.1 | 3.4 | |
| | ¼ corn ¾ wheat | 84 | 4.1 | 3.4 | |

and it is concluded from these experiments that wheat is a very satisfactory grain for broiler rations, and can be expected to support rapid growth and satisfactory finish. The fact that wheat is higher in protein than corn is an advantage in that less of the expensive protein supplements are required.

***Use of barley in broiler rations and a comparison of mash and pelleted diets:*** At present barley is the cheapest grain suitable for feeding to poultry in Canada. A certain amount is used in laying and growing rations, but very little is used in broiler rations. Accordingly, a series of experiments was undertaken to determine the possibility of using barley in broiler diets as a means of lowering feed costs.

A series of five experiments was conducted with broiler chicks reared to six weeks of age in battery brooders. Barley levels ranging from 0 to 75 per cent of the diet were tested. It was observed that substitution of barley for wheat or corn and wheat in a broiler diet decreased body weights and feed consumption. The addition of a commercial feed flavoring material to rations containing barley was not effective in counteracting the depressing effect of barley. However, feeding the ration in pellet form as opposed to mash form improved growth on all diets, regardless of barley content, to the extent that a pelleted ration containing 60 per cent barley was equal to a mash diet containing equal parts of corn and wheat.

Two experiments were conducted with broilers reared in floor pens to determine the effect of up to 50 per cent barley in broiler rations on growth rate, feed consumption, feed efficiency, and carcass grade. Each ration was fed in both mash and pellet form, as the previous tests had shown that pellets improved growth rate.

The results of the first test, in which the birds were reared to 11 weeks of age, are shown in Table 21. There were two pens of 40 birds each on each treatment, with the sexes equally represented in each pen.

TABLE 21. MEAN BODY WEIGHT OF BROILERS ON PELLETED AND MASH DIETS CONTAINING DIFFERENT LEVELS OF BARLEY

| | Males | | | Females | | | | |
|---|---|---|---|---|---|---|---|---|
| Barley (%) | Mash lb. | Pellets lb. | Increase on Pellets (%) | Mash lb. | Pellets lb. | Increase on pellets (%) | Feed/gain* Mash | Feed/gain* Pellets |
| 0 | 4.21 | 4.53 | 8 | 3.20 | 3.42 | 7 | 2.9 | 2.8 |
| 10 | 4.09 | 4.48 | 10 | 3.25 | 3.35 | 3 | 2.9 | 2.8 |
| 20 | 4.05 | 4.43 | 9 | 3.27 | 3.43 | 5 | 3.0 | 2.8 |
| 30 | 4.16 | 4.34 | 4 | 3.26 | 3.31 | 1 | 3.0 | 2.9 |
| 40 | 4.02 | 4.25 | 6 | 3.22 | 3.27 | 2 | 3.1 | 3.0 |
| 50 | 4.01 | 4.43 | 11 | 3.21 | 3.25 | 1 | 3.1 | 3.0 |

* Feed gain for combined sexes.

It may be observed that when the barley content of the ration was progressively increased from 0 to 50 per cent, the body weight of the males tended to drop, whether the diet was in mash or pellet form. The barley content of the mash diets had little effect on female body weights, but in the pelleted rations barley tended to depress weight gains, as in the males.

Pelleting the diet improved growth on all diets. The improvement was more marked in the males than the females, amounting to an average 8 per cent increase for the males and 3 per cent for the females. There appeared to be little relationship between the increase due to pellets and the level of barley in the ration. Increasing the barley in the ration caused poorer feed efficiency, as might be expected with the higher fiber content of barley. Pelleting the feed improved feed efficiency on all diets.

In a second test with broilers reared to 10 weeks of age, rations containing no barley and 50 per cent barley were fed in both mash and pellet form to N.H. × B.P.R. chicks. There were two pens of 72 birds each allotted to each treatment, with the sexes equally represented in each pen. The data for growth and feed efficiency are shown in Table 22. The results of this test

TABLE 22. MEAN BODY WEIGHT OF BROILERS ON PELLETED AND MASH DIETS CONTAINING NO BARLEY AND 50 PER CENT BARLEY, RESPECTIVELY

(72 males and 72 females per treatment)

| | Males | | | Females | | | Feed/gain* | | |
|---|---|---|---|---|---|---|---|---|---|
| Barley (%) | Mash lb. | Pellets lb. | Increase on pellets (%) | Mash lb. | Pellets lb. | Increase on pellets (%) | Mash lb. | Pellets lb. | Increase on pellets (%) |
| 0 | 3.54 | 3.88 | 9 | 2.81 | 2.90 | 3 | 2.8 | 2.6 | 8 |
| 50 | 3.26 | 3.88 | 19 | 2.74 | 2.93 | 7 | 3.0 | 2.9 | 4 |

* Feed gain for combined sexes.

confirm those of the previous one in that substitution of barley for corn and wheat caused a drop in body weight in the males but very little drop in the females when the diet was in mash form. Also in agreement with the first test, pelleting the diet increased growth on all diets and the increase was more marked with the males than the females. However, in this test there was an interaction between the barley content of the ration and the effect of pelleting. Pelleting the barley diet caused more than twice the growth increase that was obtained by pelleting the corn-wheat diet. Because of this, barley caused no growth depression in the pelleted diets such as occurred in the first trial.

The results of these experiments indicate that so far as growth is concerned barley can be used to replace wheat and corn up to 50 per cent of the diet, if the rations are pelleted. In the case of the females, barley appears to cause little or no growth depression even when the diet is in mash form.

Feed efficiency was always poorer on diets containing barley, whether the rations were in mash or pellet form. However, pelleting the diet improved feed efficiency on all diets.

The killed and dressed males from both tests were graded for finish by an experienced government grader. In both experiments, barley produced a poorer finish than corn and wheat, although the birds on the barley diets were quite acceptable in this respect. Also in both tests, pelleting the diet caused an improvement in finish over that obtained on mash diets.

The reason for the improvement in body weight, feed efficiency, and finish when the diet is pelleted is not clear. There was only a slight increase in feed consumption caused by pelleting the diets, and this increase was not statistically significant. This indicates that pelleted feed has a beneficial effect other than that of influencing feed consumption. One possibility is that pelleted diets offer no opportunity for selection of ration ingredients by the birds.

***Protein requirements of broilers:*** Protein supplements constitute one of the most expensive components of a broiler ration. The amount and quality of protein present also determines the rate of growth and feed efficiency. Consequently studies were undertaken to determine the optimum level of protein required by broilers at various stages in their growth to ensure that maximum growth rate is obtained but no protein is wasted.

The first experiment undertaken was to determine the amount of protein required from 0 to 4 weeks. Turkey pre-starters are commonly used and it was considered possible that a high protein pre-starter might also be effective with broilers. Protein levels of 22, 24, 26, and 28 per cent were tested, each diet being fed to two groups of 20 males and two groups of 20 females, a total of 80 birds per treatment. However, no advantage in growth rate was obtained from feeding more than 22 per cent protein for the first 4 weeks with either males or females.

In a second experiment, involving 960 chicks, the birds were reared to ten weeks of age. Protein levels of 26, 24, 22, and 20 per cent were tested from 0 to 4 weeks of age. Levels of 24, 22, 20, and 18 per cent were tested during the period from 4 to 7 weeks of age. All birds were finished on an 18 per cent protein diet from 7 to 10 weeks of age.

It was found that optimum growth occurred on the diet containing 22 per cent protein, carried through from 0 to 7 weeks. Higher levels than 22 per cent had no beneficial effect. In the females, the protein could be dropped from 22 per cent to 20 per cent at 4 weeks, but in the males dropping the protein to 20 per cent after 4 weeks always produced a drop in body weight. This suggests that the protein requirement from 4 to 7 weeks may be somewhat lower for females than for males.

In the experiment described above all of the birds were finished on an 18 per cent protein diet fed from 7 to 10 weeks, since it had been previously established that 18 per cent was adequate during the final 3 or 4 weeks.

However, it was decided to determine whether satisfactory performance could be achieved on finishing rations containing less than 18 per cent protein. Accordingly diets containing 18, 16, and 14 per cent protein were compared when fed to male broilers from 7 to 11 weeks of age. The results are given in Table 23.

TABLE 23. GROWTH, FEED EFFICIENCY, AND FINISH OF BROILERS RECEIVING FINISHING RATIONS OF DIFFERENT PROTEIN CONTENT

| Protein level (%) | Birds No. | Mean Body Weight | | Feed/gain 7-11 wk. lb. | Breast angle Degrees | Grade A finish (%) |
|---|---|---|---|---|---|---|
| | | 7 wk. lb. | 11 wk. lb. | | | |
| 18 | 80 | 2.3 | 3.8 | 3.6 | 72.4 | 69 |
| 16 | 80 | 2.3 | 3.8 | 4.0 | 71.4 | 87 |
| 14 | 80 | 2.3 | 3.6 | 4.2 | 70.8 | 96 |

It was found that there was no difference in final body weight between the birds receiving 18 per cent protein and those receiving 16 per cent protein. However, there was a distinct drop in body weight when the finishing diet contained only 14 per cent protein. Carcass grades for fleshing decreased as the protein level decreased, whereas grades for fat increased as the protein decreased. The best feed efficiency was obtained on the 18 per cent protein diet.

It is concluded that finishing rations (7 to 11 weeks) may be reduced in protein to as low as 16 per cent, without any appreciable drop in body weight. However, feed efficiency may suffer when 16 per cent protein rather than 18 per cent is used.

***Use of animal fat in broiler rations:*** A number of tests were conducted to determine the influence of the addition of beef tallow to broiler rations on growth and feed efficiency. In all of these tests, the rations contained 22 per cent crude protein. It was found that in all cases, feed efficiency was materially improved but rate of growth was not affected.

It was reasoned that because the birds were eating less of the high fat diets the protein in the diet should be increased. When the protein was raised to 25 per cent on a diet containing 10 per cent beef tallow it was observed that growth rate was increased, indicating that the protein content of the high fat diets had indeed been too low. The results of this experiment are shown in Table 24.

TABLE 24. EFFECT OF HIGH FAT AND HIGH PROTEIN ON GROWTH AND FEED EFFICIENCY OF BROILERS

| Treatment | Birds No. | Mean body wt. | | Feed/gain | |
|---|---|---|---|---|---|
| | | 7 wk. lb. | 10 wk. lb. | 7 wk. lb. | 10 wk. lb. |
| 22% protein | 140 | 2.0 | 3.5 | 2.8 | 3.2 |
| 22% protein + 10% fat | 140 | 2.0 | 3.5 | 2.6 | 3.1 |
| 25% protein | 140 | 2.0 | 3.4 | 2.8 | 3.2 |
| 25% protein + 10% fat | 140 | 2.2 | 3.7 | 2.5 | 2.9 |

This experiment was conducted in open-front colony houses during cold weather. Subsequent tests conducted during hot weather have not always confirmed the results of the first test and where growth increases have been obtained with high fat and high protein diets they have been of lesser magnitude. It now appears that low environmental temperatures may increase the growth response to added fat and increased protein in broiler diets, although improved feed efficiency can be expected under most conditions.

### Turkey Broiler Rations

In recent years a market has been developed for young turkeys 12 to 15 weeks of age. For want of a better name, these birds are sometimes called turkey broilers, by analogy with chicken broilers, although turkeys of this age are too large for broiling. One of the problems in marketing these young turkeys has been to achieve a satisfactory finish. A common complaint has been that the dressed carcasses appear 'blue', which is caused by lack of fat beneath the skin.

Two experiments were conducted to determine whether reducing the protein content of the diet during the final weeks would improve the finish on turkey broilers. All of the birds in both tests were started on a 28 per cent protein diet from 0 to 4 weeks. After 4 weeks they were switched to a 26 per cent protein diet which continued until the finishing ration was fed. Duration of both tests was 14 weeks at which time the birds were killed and dressed and then graded for finish by an experienced government grader.

The finishing treatments, body weights, and carcass grades on each treatment are shown in Table 25. In experiment 1, there were no marked differences in finish between the treatments. Dropping the protein to 15 per cent at 12 weeks caused a drop in body weight, but dropping it to 21 per cent at 10 weeks had no effect. All of the birds in this experiment were considered by graders to be acceptable for finish except a few that graded C.

TABLE 25. EFFECT OF PROTEIN LEVEL ON GROWTH AND FINISH OF TURKEY BROILERS

| Experiment | Finishing treatment | Number of birds | Mean body wt. (14 weeks) lb. | Finish | | |
|---|---|---|---|---|---|---|
| | | | | A % | B % | C % |
| | Control 26% protein 10 to 14 weeks | 72 | 7.6 | 45 | 52 | 3 |
| 1 | 21% protein 10 to 14 weeks | 73 | 7.6 | 51 | 46 | 3 |
| | 15% protein 12 to 14 weeks | 75 | 7.3 | 40 | 58 | 2 |
| | Control 26% protein 8 to 14 weeks | 97 | 7.7 | 49 | 47 | 4 |
| 2 | 21% protein 8 to 14 weeks | 80 | 7.5 | 37 | 60 | 3 |
| | 15% protein 10 to 14 weeks | 77 | 6.0 | 10 | 79 | 11 |

In experiment 2, an outbreak of blackhead interfered seriously with the birds and the appearance of the dressed carcasses was not equal to that of the birds in experiment 1. When the protein was dropped to 21 per cent at 8 weeks there was a slight drop in body weight and poorer finish. Dropping the protein to 15 per cent at 10 weeks caused a marked drop in body weight and much poorer finish.

It is concluded from these tests that birds with a very acceptable finish can be reared on a 26 per cent protein diet to 14 weeks. However, equally satisfactory results are obtained when the protein is dropped to 21 per cent at 10 weeks. If this is done as early as 8 weeks, however, both body weight and finish are adversely affected. A ration containing only 15 per cent protein appears to be too low at any stage of the turkey broiler's growth.

## Antibiotics and Growth Stimulants in Poultry Feeds

A number of experiments have been conducted on the growth response to antibiotics and arsenic compounds in broiler rations, on the effect of antibiotics in laying rations, and on the influence of environment on the growth response to antibiotics and arsenic compounds.

***Growth response to antibiotics and growth stimulants:*** Several tests were conducted to measure the growth response obtained with various antibiotics, arsenic compounds, and surface active agents. The results of a typical experiment of this type are shown in Table 26.

TABLE 26. EFFECT OF GROWTH STIMULANTS ON THE BODY WEIGHT OF BROILER CHICKS

| Treatment | Number of Survivors | Mean body weight (7 weeks) | | |
|---|---|---|---|---|
| | | M gm. | F gm. | Combined gm. |
| Control | 49 | 790 | 660 | 725 |
| Penicillin (10 ppm.) | 56 | 875 | 715 | 795 |
| Arsonic acid* (90 ppm.) | 49 | 895 | 710 | 810 |
| Arsanilic acid (90 ppm.) | 51 | 790 | 640 | 720 |
| Ethomid C-15** (2 lb./ton) | 55 | 735 | 625 | 680 |

* 3 nitro-4-hydroxyphenylarsonic acid.
**Surface active agent.

In this experiment broiler chicks were reared in floor pens to 7 weeks of age. Approximately a 10 per cent increase in body weight was obtained with penicillin and 3-nitro-4-hydroxyphenylarsonic acid in the diet. No response was obtained with arsanilic acid. Ethomid C-15, a surface active agent reported to stimulate growth, actually depressed growth.

***Influence of environment on response to growth stimulants:*** It has been known for some time that antibiotics cause very little or no growth stimulation in a clean environment in which poultry have not been reared before. However, it was not known whether arsenic compounds and surface active agents might behave similarly. A test was therefore set up to compare two environments, one clean and one contaminated, and to determine the response to various growth stimulants in the two environments. The clean environment was a radiant heated house that had been cleaned, disinfected, painted, and left empty for several months. The birds in this house were reared on wire floors in new battery brooders that were being used for the first time. In the contaminated environment the birds were reared on deep litter in floor pens and in proximity to older stock.

Two pens of birds in each environment were allotted to each treatment. Each pen contained 50 chicks, half males and half females. The birds were reared to 6 weeks of age. The results of the test are shown in Table 27.

TABLE 27. EFFECT OF ENVIRONMENT ON RESPONSE OF CHICKS TO GROWTH STIMULANTS

| Treatment | Mean body weight (gm.) | | | | | |
|---|---|---|---|---|---|---|
| | Old environment | | | New environment | | |
| | 2 weeks | 4 weeks | 6 weeks | 2 weeks | 4 weeks | 6 weeks |
| Control | 130 | 360 | 650 | 130 | 375 | 705 |
| Penicillin (10 ppm.) | 140 | 395 | 715 | 135 | 385 | 745 |
| Arsonic acid (90 ppm.) | 130 | 370 | 715 | 130 | 360 | 715 |
| Arsanilic acid (90 ppm.) | 120 | 360 | 655 | 130 | 370 | 725 |
| Ethomid C-15 (2 lb./ton) | 125 | 350 | 650 | 135 | 370 | 720 |
| Average | 130 | 370 | 680 | 130 | 370 | 720 |

There was no overall difference in body weights between the two environments up to 4 weeks of age, but at 6 weeks the clean environment was superior to the contaminated house. Penicillin stimulated growth at 4 weeks and 6 weeks in the old environment but not until 6 weeks in the clean house, and then to a lesser extent. Presumably infection had built up to some extent after 6 weeks in the new environment. Arsonic acid stimulated growth in the contaminated house, but not in the clean house. It therefore reacts to the type of environment in a similar manner to penicillin, and to this extent its mode of action in stimulating growth is similar to that of antibiotics. Neither arsanilic acid nor Ethomid C-15 stimulated growth in either environment.

The lack of response to arsanilic acid in tests at Ottawa may be a characteristic of this location, since some workers at other locations have obtained a growth response with this compound. However, the lack of response to Ethomid C-15 is in agreement with the results of the majority of investigators who have tested surface active agents.

***Effect of antibiotics on laying hens:*** Two experiments were conducted to determine the influence of an antibiotic in the feed of laying hens, as measured by the effect on egg production, feed consumption, egg shell thickness, and egg yolk color.

The first test was conducted with 64 White Leghorn hens that had been laying for approximately a year and were in the latter part of the declining period of production. The birds were housed in individual cages in a laying battery. Half the birds received laying mash containing 30 gm. per ton of procaine penicillin. The other half received the same diet without the antibiotics.

The antibiotic fed birds were 4 per cent heavier at the end of the six weeks test period and consumed 8 per cent more feed. They also laid an average of 1.5 eggs more per bird, an increase of 16 per cent, and the eggs were 4 per cent larger than those laid by the control birds. The specific gravity of the eggs laid by the birds fed antibiotic was slightly greater, indicating greater egg shell thickness. The yolks of the eggs from the antibiotic group were deeper in color on the average, indicating a greater deposition of carotenoid pigments.

The number of birds employed in this test was limited and the differences obtained between treatments for certain criteria such as egg production were probably not sufficiently large to be significant. Nevertheless, the fact that penicillin had a positive influence on all of the criteria measured suggested a real effect and therefore the experiment was repeated. However, in the second test 96 Barred Rock pullets were used rather than the yearling hens used in the first test. Also, two basal diets were used, one containing a normal calcium level and a second containing a sub-optimal level of calcium (1.3 per cent). Each of these diets was fed with and without penicillin (30 gm. per ton).

Penicillin caused a 6 per cent increase in feed consumption on both the low calcium and the normal calcium diets. Body weight on the normal calcium diet was increased by penicillin but was decreased by penicillin on the low calcium diet. The antibiotic had no appreciable effect on egg production or specific gravity of the eggs.

The effect of the antibiotic in increasing feed consumption was consistent in both tests. However, the second test did not confirm the results of the first test with respect to the effect of penicillin on egg production and specific gravity. Two factors may have been responsible for the disagreement in results of the two experiments. First, the birds were yearling hens in declining production in the first test. One might expect such birds to be stimulated more than the pullets in the peak period of production that were used in the second test. Another factor was the difference in environmental temperature between the two tests. The first experiment was run during hot summer weather, and the second in the cool winter months. Temperature is known to affect calcium metabolism and the birds in the first test were probably under greater stress in this respect than those in the second.

## Rations for Breeding Geese

A number of rations for breeding geese have been tested and compared in experiments conducted over a period of three breeding seasons. The purpose of these experiments was to determine the general type of ration required by breeding geese. Facilities and circumstances did not permit intensive investigation of the requirements for individual nutrients.

Prior to the decision to conduct nutrition experiments on the flock of breeding geese, they had been receiving a diet consisting of duck breeder pellets, scratch grain, and alfalfa hay. Because of the difficulty of determining feed consumption on this feeding program, a comparable diet was formulated and fed as pellets, which contained all of the ingredients formerly offered as separate components. This diet (A) was comparable in composition to a chicken laying mash, and contained approximately 15 per cent protein. In an effort to promote better performance in the breeding flock, a second diet (B) containing more and better quality protein (18 per cent) and supplementary vitamins, was compounded and compared with the basal diet. Diet (B) was formulated to provide more than adequate amounts of all nutrients that could conceivably influence performance.

All eggs laid during the breeding season were incubated. The results of the test are shown in Table 28. It may be observed that Ration (B) caused no appreciable improvement in performance with respect to egg production, fertility, or hatchability. Because of the high variation between individual birds, the difference in egg production between rations shown in Table 28 is

TABLE 28. PERFORMANCE OF BREEDING GEESE RECEIVING TWO DIFFERENT DIETS

| — | Ration A | Ration B |
|---|---|---|
| Number of females* | 32 | 32 |
| Mean egg production No. | 19.4 | 20.9 |
| Fertility % | 72 | 70 |
| Hatch of fertile eggs % | 74 | 69 |
| Initial body wt. (lb.) males | 13.0 | 13.0 |
| females | 12.1 | 12.0 |
| Final body wt. (lb.) males | 11.2 | 12.0 |
| females | 8.5 | 9.2 |
| Feed consumption (lb./bird/day) | 0.40 | 0.42 |

* The mating ratio was one male for each 4 females.

not significant. The only things influenced by the diets were body weight and feed consumption. Both males and females receiving ration (B) were almost one pound heavier at the end of the test than those receiving ration (A). It is concluded that 15 per cent protein is adequate for breeding geese and that their requirements for other nutrients do not vary greatly from those of laying hens.

It has long been known that geese refuse to consume alfalfa pasture. However, the diets offered the geese contained as much as 25 per cent alfalfa meal. To determine whether the refusal of the goose to consume fresh alfalfa was associated with any harmful effect of this material, two diets were compared that were identical in all respects except that one contained 15 per cent dehydrated cereal grass and the other 15 per cent dehydrated alfalfa meal. Each diet contained 15 per cent protein and was comparable in quality to a chicken hatching ration except for a higher level of vitamin A. Both diets were fed in pellet form. Oyster shell and grit were fed free choice.

Again no differences in performance were observed between the geese receiving the two diets. The alfalfa meal had no adverse effects on egg production, fertility, or hatchability.

All of the diets tested in the first two years contained a large excess of vitamin A derived mainly from the green feed incorporated in the diet. To determine whether lower levels would be sufficient, two diets identical in all respects except vitamin A supplements were compared. One diet contained 15 per cent green feed in the form of 8 per cent dehydrated alfalfa meal and 7 per cent dehydrated cereal grass. The other diet contained 6 per cent green feed, comprised of equal parts of alfalfa meal and cereal grass.

No difference between the diets was observed, as measured in terms of egg production, fertility, and hatchability. This indicated that a diet in which vitamin A is supplied by 6 per cent dehydrated green feed, and carrying 15 per cent crude protein, appears to support optimum performance in breeding geese. Such a diet is very similar in composition to a chicken hatching mash, and it would appear that breeding geese can be fed the same diet as breeding hens, provided the ration is offered in pellet form. It is quite likely that the minimum requirements for breeding geese differ from those for hens but unfortunately facilities did not permit investigations along this line.

## Nutritional Requirements of Growing Geese

Because there was practically no information in the scientific literature on the nutrition of geese, experiments were undertaken to study the growth rate, feed consumption, efficiency of feed conversion, and nutritional requirements of growing geese.

***Growth rate and efficiency of feed utilization of Pilgrim geese reared in confinement:*** When experiments on geese were contemplated it was decided that since there was no information on the growth rate and feed efficiency of Pilgrim geese, this was the first information that should be obtained. For this purpose the goslings were reared in confinement on a pelleted diet. The formula of the diet was based largely on the known requirements of ducks. The diet contained approximately 19 per cent protein and was similar in composition to a chick starter except that it contained 3 per cent brewers yeast, which is a rich source of niacin and possibly other factors.

Male goslings on this program gained at the rate of approximately 1 pound per week until they were 10 weeks of age. The females gained at the same rate as the males until they were 4 to 5 weeks old, after which their growth rate was somewhat less than the males. The feed-gain ratio was less than 3 pounds of feed per pound of gain up to 8 weeks, when the geese weighed approximately 8 pounds.

In the graph shown in Figure 22 the growth rate of geese is compared with that of turkeys, ducks, and chickens.

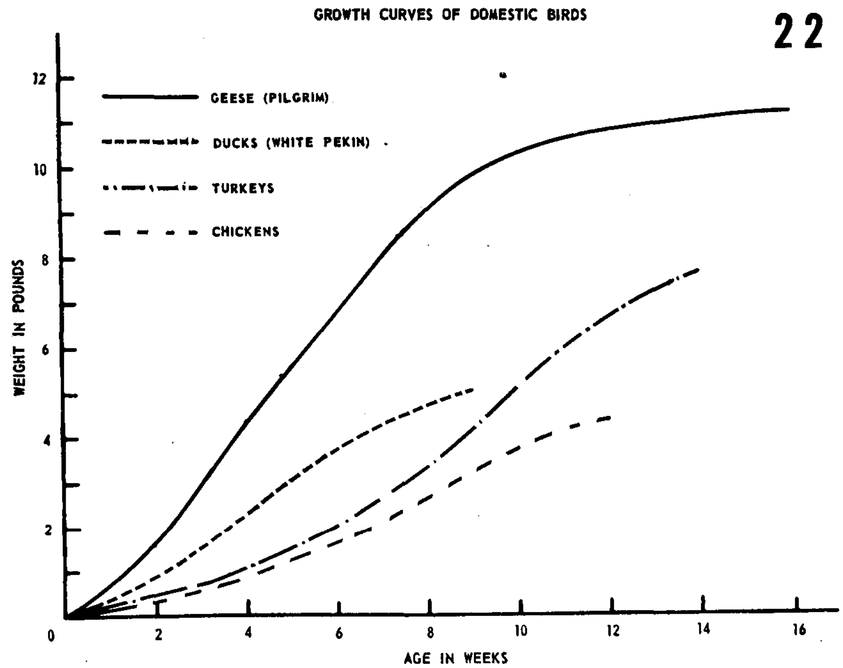



Figure 22. Growth curves of domestic birds reared in confinement.

***Protein requirement of goslings:*** Three experiments were conducted to determine the level of protein required for top growth in Pilgrim goslings. It was established that geese do not require more than 20 per cent crude protein in the diet for optimum growth. Furthermore, it was found that protein in excess of 22 per cent of the diet had a marked adverse effect on growth. Apparently goslings do not tolerate an excessively high protein intake.

The results of these experiments were surprising since it means that geese, gaining weight at five times the rate of broiler chicks, require a lower level of dietary protein. Similarly, turkey poults gaining at one third the rate of geese, require 6 per cent more crude protein in the diet. The explanation of these species differences is still not clear.

***Calcium and phosphorus requirements of goslings:*** Three experiments were conducted to obtain information on the calcium and phosphorus requirements of goslings. The lowest level of calcium that could be obtained using a ration containing common ingredients was 0.4 per cent. This ration carried 0.7 per cent total phosphorus which included approximately 0.2 per cent inorganic phosphorus.

It was found that growth was as good at the lowest levels of calcium and phosphorus as it was when the calcium was increased to 1 per cent of the diet, which is the recommended level for chicks. No benefit was derived from increasing the phosphorus beyond the level of 0.7 per cent which occurred in the basal diet.

In a second experiment, when the calcium was increased from 0.4 per cent to 0.8 per cent, there appeared to be a slight improvement in growth. However, increased phosphorus still had no beneficial effect.

The third test was designed to achieve a low enough level of calcium to produce a calcium deficiency in the goslings. In this experiment the fish meal was replaced with fish solubles, which are much lower in calcium, and dried skim milk powder with dried whey. This lowered the calcium to 0.2 per cent.

On this diet rickets was produced in the goslings. A diet containing 0.5 per cent calcium corrected the rickets and produced normal growth. No increase in body weight was effected by further increasing the calcium to 0.8 per cent.

In the last two experiments, bone ash, bone calcium, and bone phosphorus were determined on one tibia from each bird. It was found that these criteria were not affected by any of the diets except the one containing 0.2 per cent calcium which had produced the rickets.

It is concluded from these experiments that the growing gosling does not require more than 0.5 per cent calcium in the diet, nor more than 0.7 per cent total phosphorus (0.2 per cent inorganic phosphorus).

***Influence of antibiotics and arsonic acid on the growth of goslings:*** Two experiments, involving a total of 174 day-old goslings, were conducted to determine the effect on growth of including penicillin, aureomycin, and 3-nitro-4-hydroxyphenylarsonic acid in the diet of goslings. The penicillin and aureomycin were each tested at two levels, 25 ppm. and 100 ppm. The arsonic acid was added at the level of 50 ppm. The tests were terminated when the goslings were 4 and 5 weeks of age, in experiments 1 and 2, respectively.

In the first experiment neither penicillin nor arsonic acid stimulated growth, and actually depressed growth in the females. In the second test penicillin and aureomycin produced a transitory increase in body weight up to 2 weeks of age, but this disappeared by 4 weeks and the antibiotics appeared to depress growth at 5 weeks. Arsonic acid produced no growth response at any age.

It is concluded from these experiments that no appreciable growth response can be expected with penicillin or 3-nitro-4-hydroxyphenylarsonic acid in the diet of goslings, and there is some indication that they can cause growth depression.

***Manganese requirements of goslings:*** Goslings are subject to a perosis-like condition in which the legs become deranged at the hock joint. It has been found by a number of workers that niacin added to the diet will prevent this condition. However, in chicks, a lack of manganese has been associated with perosis. It was decided to determine whether manganese played a similar role in goslings.

Diets were compounded with levels of manganese ranging from 18 ppm. to 55 ppm. The level of 18 ppm. is somewhat below what would occur in normal diets without added manganese. It was found that the goslings grew just as well on the minimum level of manganese as on the higher levels and showed no evidence of leg weakness. These diets all contained supplementary niacin. It appears that if manganese is needed by the gosling for the same purposes as by the chick, the requirement of the gosling is much lower.

***Effect of sodium chloride in the diet of goslings:*** In four tests to determine the effect of added salt in the diet of goslings there was considerable difference in results between experiments. In Table 29 the results of these tests are shown.

It will be observed that in the first test there was an increase in body weight when 0.5 per cent salt was added to the diet. However, in the second test, 0.5 per cent was no better than 0.25 per cent. In the third test the effect of 1 per cent added salt was dramatic, whereas in the fourth test there was only a moderate response to added salt. It is interesting that in the last test as much as 3 per cent added salt had no adverse effects and actually supported top growth.

TABLE 29. INFLUENCE OF DIETARY SODIUM CHLORIDE ON GROWTH OF GOSLINGS

| Experiment No. | Added salt % | Birds No. | Mean body weight lb. |
|---|---|---|---|
| 1 (5 weeks) | 0 | 26 | 4.9 |
| | 0.25 | 26 | 5.0 |
| | 0.5 | 26 | 5.3 |
| 2 (6 weeks) | 0.25 | 48 | 6.5 |
| | 0.5 | 48 | 6.4 |
| 3 (4 weeks) | 0 | 24 | 3.0 |
| | 1 | 24 | 4.3 |
| 4 (5 weeks) | 0 | 14 | 5.0 |
| | 1 | 14 | 5.2 |
| | 2 | 14 | 5.2 |
| | 3 | 14 | 5.4 |

It appears from these results that the addition of 1 per cent salt to the diet would be desirable. However, no reason is known for the marked difference between experiments in the degree of response. Presumably some factors of which we are not aware influence the response to added salt.

## Methods of Rearing Geese on Pasture

The goose is able, if necessary, to derive the major part of its food from eating grass. Because it is capable of utilizing pasture and is sufficiently hardy to be placed on range at a very early age, and also because geese reared in confinement require a great deal of labor to keep them clean, it is much more practical to rear them on pasture.

Although sufficient experiments on this subject have not been conducted to permit recommendation of the most economical method of rearing geese on pasture, considerable information on different diets and levels of feed restriction has been obtained.

Experiments were conducted over a period of three pasture seasons. The first year two diets were fed. One consisted of a mixture of equal parts of goose starter pellets (19 per cent protein) and grain. The protein content of the mixture was approximately 15.5 per cent. This diet was fed ad libitum to one group and was restricted to 2 hours feeding time per day for a second group. The other diet consisted of grain alone fed free choice. The results of these three treatments can be observed in Figure 23.

It will be noted that restriction of the pellet grain mixture did not depress growth appreciably until after the geese were ten weeks of age. Possibly the fact that the pasture was becoming depleted at this time accounts for the drop in growth after 10 weeks. On the other hand, the grain alone supported much poorer growth throughout the entire period.

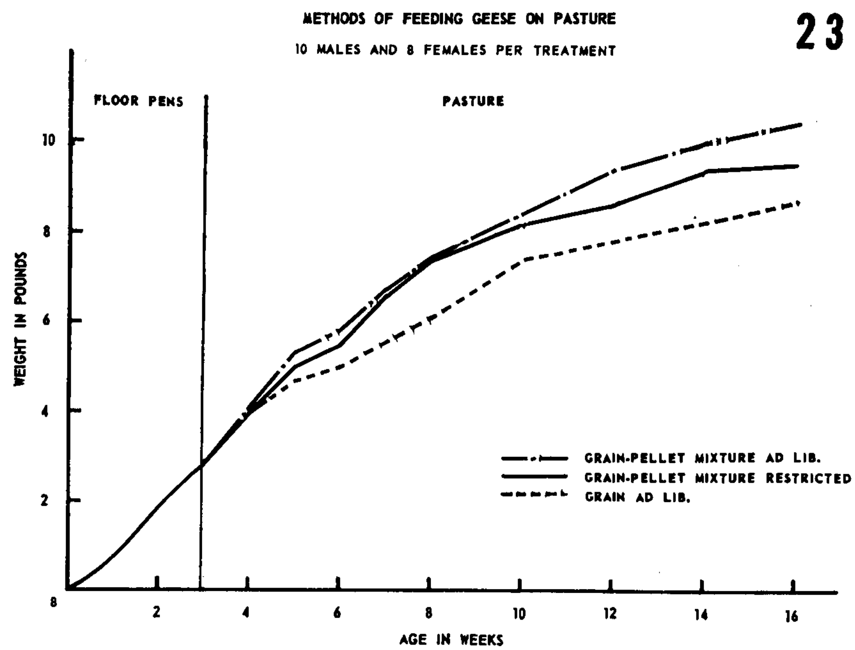



Figure 23. Growth response to different methods of feeding geese on pasture—I.

It was considered possible that the poor growth on the grain feeding was a result of low protein and vitamins and that if the grain were restricted the geese would be forced to eat more grass and obtain the needed protein and vitamins. Accordingly the experiment was repeated, with the difference that the grain feeding was restricted to 2 hours per day. The results are shown in Figure 24.

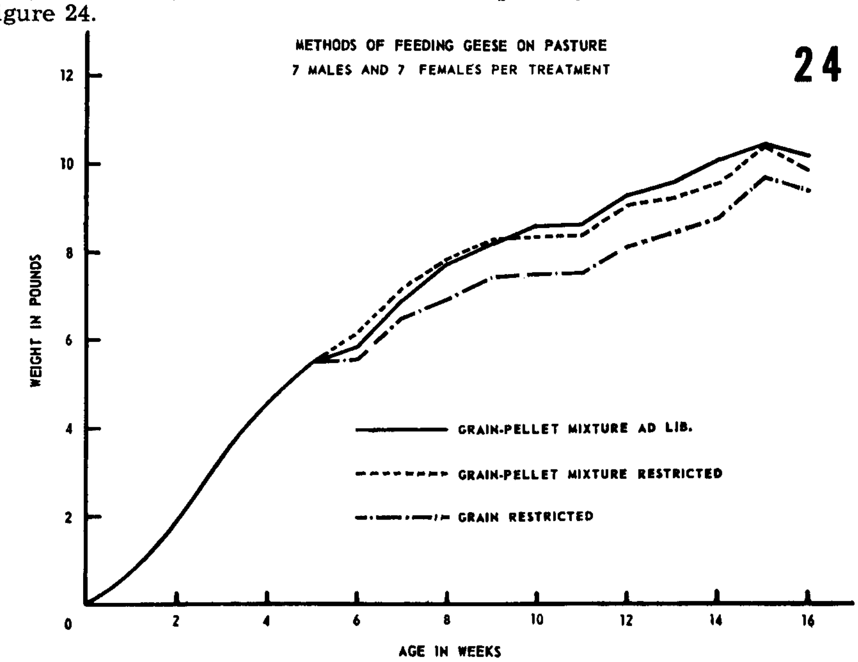



Figure 24. Growth response to different methods of feeding geese on pasture—II.

Restricting the grain did not promote growth equal to that on the restricted pellet-grain mixture. It must be concluded that grain alone fed to geese on pasture whether free choice or restricted does not support optimum growth.

Two succeeding experiments were conducted to determine how much feed is required to support optimum growth of geese on pasture. The feed in these experiments was allotted at arbitrary rates. Feeding rates ranged from one pound per goose per week to 4 pounds per week, allotted in equal daily portions.

The geese receiving 2 pounds of feed per week grew at a satisfactory rate. More than 2 pounds did not increase growth appreciably. However, less than 2 pounds caused a considerable drop in body weight. The diet fed in these tests was the pellet-grain mixture described above.

Further experiments are required to determine whether a satisfactory carcass can be obtained when geese are severely restricted on pasture and then finished for a short period on full feed.

### Hormone Residues in the Tissues of Estrogen Treated Birds

Up to the present time, the use of estrogenic compounds for fattening poultry has not been permitted in Canada. One of the reasons for prohibiting their use has been the danger that appreciable residues of the hormone might remain in the edible portions of the carcass and be consumed by humans. Accordingly, experiments were conducted to determine the estrogenic activity remaining in the tissues of birds treated with two estrogenic compounds, diethylstilbesterol, which is implanted in pellet, paste or liquid form beneath the skin, and dienestrol diacetate, which is incorporated in the feed.

Turkeys and chickens were treated with varying amounts of diethylstilbesterol in the form of small pellets implanted beneath the skin on the back of the head. The dienestrol diacetate was fed at a level of 0.01 per cent in the feed and each compound was used to treat cockerels only.

At the end of the treatment period the birds were slaughtered, the tissues removed and extracted with alcohol and ether. The alcohol and ether were evaporated from the extracts under reduced pressure and the remaining extracts were assayed for estrogenic activity. Two methods of assay were used, the vaginal smear method using spayed female rats and the uterine weight method using weanling female rats. The latter method was found to be much more sensitive. These assays were conducted by the Animal Chemistry Unit of the Chemistry Division, Science Service, and the co-operation of the individuals concerned is gratefully acknowledged.

The tissues tested were muscle, skin, liver, and visceral fat. Up to 2 micrograms of estrogen per 100 gm. of liver were detected from chickens and turkeys treated with diethylstilbesterol. No estrogenic activity was detected in the muscle, skin, and visceral fat. As high as 7 micrograms of estrogen per 100 g. of tissue were found in the liver of cockerels treated with dienestrol diacetate, and smaller amounts were found in the skin and visceral fat. None was found in the muscle.

The amounts of estrogen present in the tissues of birds treated with dienestrol diacetate were greater than the amounts found when diethylstilbesterol was the estrogen used. This might be a characteristic of the compound used, or it might be due to the method of administration. Since dienestrol diacetate is incorporated in the feed it is probably absorbed at a constant rate throughout the treatment period, whereas the rate of absorption from diethylstilbesterol pellets would tend to decrease with the advance of the treatment period. At least 11 days elapsed between implantation of the diethylstilbesterol pellets and slaughter of the birds.

The amounts of estrogenic activity detected in the tissues of treated birds in these studies were relatively small and were probably not high enough to constitute a health hazard to humans consuming the meat.

### Studies on the Fertilizing Capacity of Cockerel Semen

The problem of obtaining high fertility and hatchability is of primary importance to poultry breeders and hatcherymen. Any improvement in these characteristics is reflected in an increased income to those concerned with the production of chicks. In these studies the object in most cases was to determine the effect of treating the semen itself on fertility and hatchability, although in one instance a dietary treatment was used and its effect on the semen measured.

***Effect on fertility and hatchability of iodinated casein in the diet:*** The Broad Breasted White breed developed at Ottawa possesses excellent meat characteristics but the cockerels possess relatively low fertility. It was hoped that by feeding iodinated casein some improvement in fertility might be obtained.

Thirty-two cockerels of the breed described were housed in individual cages. They were divided into four treatment groups of 8 birds each. One group served as a control and the remaining three groups received levels of 5, 10, and 15 grams of thyroprotein per 100 lb. of feed, respectively.

After seven weeks on treatment semen samples were obtained regularly from the cockerels and used to inseminate hens. The fertility of the cockerel was measured by the length of time that the hens remained fertile (i.e. laid fertile eggs) after a single insemination. Six hens were inseminated with the semen from each cockerel, making a total of 192 hens inseminated in the course of the test.

The semen from each cockerel was also subjected to five laboratory tests, (1) Initial motility, (2) Progressive motility, (3) Density, (4) Volume, and (5) Percentage live spermatozoa.

In both the first and second tests it was found that treatment with 5 grams of thyroprotein per 100 pounds of feed decreased the duration of fertility. Both 10 and 15 grams of thyroprotein neither depressed nor increased duration of fertility after 7 weeks' treatment. However, after 17 weeks, 15 grams depressed duration of fertility whereas 10 grams increased fertility.

It appears from these results that 10 grams of thyroprotein is the best level of those tested. Presumably 5 grams is sufficient to depress thyroid gland activity but not sufficient to replace it, and 15 grams is excessive.

The birds on all treatments gained weight throughout the test and this was not influenced appreciably by the particular level of thyroprotein being fed. However, feed consumption was influenced by the thyroprotein treatments. The group receiving 5 grams ate slightly less than the control group, whereas those receiving 10 grams ate slightly more and the 15 gram group considerably more.

***Effect on duration of fertility and hatchability of adding thyroxine directly to the semen:*** Semen diluted with semenal plasma was treated with D-L-thyroxine. The semen was obtained from two breeds of cockerels, White Leghorns and Broad Breasted Whites. Eight birds of each breed were used and the semen from birds of the same breed was pooled.

Nineteen hens were inseminated with treated and untreated semen from each breed on each of four successive days. Duration of fertility of the hens after a single insemination, and hatchability of the eggs were determined.

Treatment with thyroxine slightly decreased the duration of fertility with semen from White Leghorns and slightly increased duration of fertility with semen from Broad Breasted Whites.

Hatchability of the eggs laid one week after insemination was not influenced by treatment of the semen with thyroxine. However, thyroxine considerably improved the hatchability of eggs laid the second week after insemination.

***Effect of light on the fertilizing capacity of spermatozoa:*** It has been observed that light waves in the visible range have an injurious effect on sea urchin spermatozoa. It was considered possible that light might have a similar effect on sperm of the domestic fowl. To test this possibility semen was treated in various ways with light and the fertilizing capacity compared as measured by duration of fertility.

Semen was collected under conditions of almost total darkness (small red light) and received in a tube painted black. A pooled sample obtained from 12 cockerels was divided into 4 equal portions. One portion was used for insemination immediately after collection. A second sample was held for 2 hours in total darkness. The third sample was held for 2 hours in room light. The fourth portion was exposed to concentrated light from a 200-watt light bulb for 2 hours. A water cell was placed between the light and the semen sample to prevent an increase in temperature of the semen.

Each sample was used to inseminate 17 hens after the two-hour treatment period. This procedure was repeated on three successive days, so that 51 hens were inseminated with each semen treatment.

Treatment of the semen with strong light caused no reduction in duration of fertility. In fact, duration of fertility was actually longer with semen treated with strong light than it was for the control group, although the difference was not statistically significant.

Hatchability was not influenced by the semen treatments. It is concluded that unlike sea urchin sperm, cock sperm is not harmed by visible light.

***Effect of time and temperature of storage on the fertilizing capacity of fowl semen:*** Three experiments were conducted to determine the optimum temperature above freezing at which to store fowl semen, and also to measure the decrease in fertilizing capacity that occurs when semen is stored for various lengths of time.

In two initial experiments storage temperatures of 0° C., 10° C., 20° C., and 30° C., were tested for holding periods up to 8 hours. It was found that temperatures of 10° C. and 20° C. were equally satisfactory. A holding temperature of 0° C. gave good fertility after 2 hours storage, but there was a rapid drop in fertility when the semen was held for longer than 2 hours. A holding temperature of 30° C. gave very poor fertility at all holding times. These results are shown in Table 30.

TABLE 30. AVERAGE DURATION OF FERTILITY OF HENS INSEMINATED WITH SEMEN HELD AT DIFFERENT TEMPERATURES

| Temperature | Treatment Holding Time (hr.) | Average duration of fertility (days) | |
|---|---|---|---|
| | | Expt. 1 (14)* | Expt. 2 (26)* |
| 0° C. | 2 | 9.9 | 6.0 |
| | 4 | 6.1 | |
| | 6 | 2.8 | 1.9 |
| | 8 | 1.4 | |
| 10° C. | 2 | 8.1 | 10.1 |
| | 4 | 7.6 | |
| | 6 | 4.1 | 7.8 |
| | 8 | 5.8 | |
| 20° C. | 2 | 8.5 | |
| | 4 | 3.6 | |
| | 6 | 7.2 | |
| | 8 | 5.6 | |
| 30° C. | 2 | 1.7 | |
| | 4 | 1.4 | |
| | 6 | 0 | |
| | 8 | 0 | |
| Control | | 11.1 | 12.0 |

* No. of hens inseminated per treatment.

Having established that the best storage temperature was somewhere in the range of 10° C. to 20° C., two experiments were conducted to compare temperatures of 10° C., 15° C. and 20° C., to determine whether differences between these temperatures could be shown. The results of these tests are shown in Figure 25.

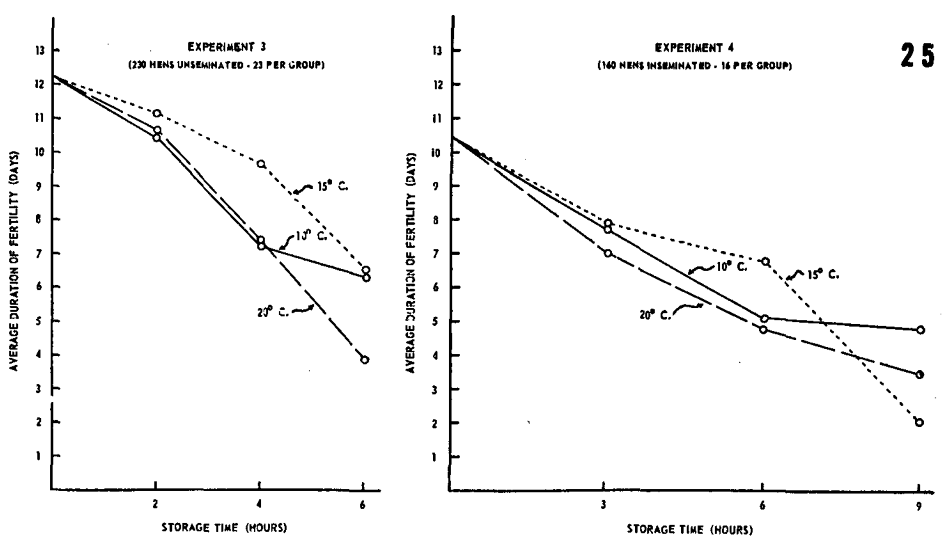



Figure 25. Mean duration of fertility of hens inseminated with semen held at different temperatures.

In five of six comparisons a temperature of 15° C. gave the longest duration of fertility. However, statistical analysis showed no significant differences between these temperatures. It is concluded that temperatures in the range of 10 to 20° C. (50 to 68° F.) are optimum for holding fowl semen. However, there was evidence that a storage temperature of 15° C. may be slightly better than 10° C. or 20° C.

## ORGANIZATION AND ACTIVITIES

The staff of the Poultry Division conducts research work at Ottawa and directs a research program on 19 Experimental Farms across Canada. The nature and scope of the research program varies with the facilities and staff at each of the units, which may be grouped as follows:

(1) Ten of the 19 Farms have reasonably large accommodation for birds, although all are not equipped with laboratories, and the staff members are trained in poultry research. The specialists at these Farms collaborate with the staff at Ottawa in large-scale tests and also conduct research on their own initiative.

(2) Five Farms have good facilities and bird accommodation, but none has a poultry specialist. Research on these Farms is closely tied in with the Ottawa program and is also conducted on a professional level.

(3) Four Farms have limited facilities, with a poultryman in charge, and are located in districts with an established poultry industry. Each conducts a limited amount of experimental work of a practical nature on local problems and serves as a source of information to the public.

In addition to the 19 Farms on which a research program is conducted there are 4 Farms, located respectively in central British Columbia, the North-West Territories, and the Yukon, on which a small flock is maintained for demonstration purposes. These serve as a source of information on good poultry practices in areas where opportunities in poultry husbandry are limited but increasing.

An example will serve to clarify the role of the major Experimental Farms. In the breeding research project work of the Poultry Division, one of the most important subjects under investigation is concerned with the inheritance of egg production. The investigation of so variable a character as egg production requires many laying birds, and in order that the results should have the greatest possible application, the birds have to be carried in large flocks each with as different an environment as possible. As a result, five of the larger Branch Farms co-operate with Ottawa in this project, utilizing most of their resources. In addition, where feasible, they carry also an individual project of their own that may or may not be related to the major co-operative project. The opportunity to utilize such large populations of birds in poultry research under such diverse environmental conditions is advantageous.

Research in poultry nutrition has different requirements, particularly in the matter of laboratory facilities. For this reason, on one Branch Farm in the Maritime Provinces and one in the Prairie Provinces, specialized nutrition units have been set up to take care of regional feeding problems as well as to contribute to knowledge on basic problems of poultry nutrition. A Western Branch Farm also specializes in turkey research in the nutritional field.

Apart from the direction of work on the Branch Farms, there is at Ottawa a program of research with chickens, turkeys, and geese. Much of the research is of a more basic and fundamental nature, as for example, in the field of physiology. Research with turkeys is genetic in nature and complements that of the Swift Current Experimental Farm, which specializes in turkey nutrition. Genetic, nutritional, and management research on a large scale are involved in the research program with geese and in order to provide greater populations, this work has been expanded to a Branch Farm in Quebec.

For the past few years, the changing nature of the poultry industry in Canada has necessitated an increased emphasis on research on Experimental Farms. Demonstration and extension work have given way to research as the need for the former has lessened in the longer established poultry production areas, and has become the responsibility of the Branch Farms and Substations in the remote regions. With the more basic type of research at Ottawa, the whole makes an increasingly better balanced organization as time goes on.

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# PROJECTS OF THE POULTRY DIVISION

Genetics:

The feasibility of selection based on the progeny test as a method for increasing the egg producing ability of fowl.

Breeding for improved production characteristics in geese.

A test of the egg producing ability of unselected families of hens kept for a second production year following a forced moult.

The effect of relaxed selection on the performance of selected strains of egg producing fowl.

The improvement of the Broad Breasted White breed of fowl for meat production.

Selection methods for production of broiler strains of turkeys.

The measurement of egg quality traits in several White Leghorn strains in different environments and the determination of their relationship to selection for egg production.

The duration of fertility in various breeds and strains of fowl following artificial insemination with different doses of semen.

Genetic and physiological differences in the spermatozoa of the domestic fowl.

Nutrition:

Antibiotics and growth stimulants in poultry feeds.
Chicken broiler rations.
Nutritional requirements of growing geese.
Nutritional requirements of breeding geese.
Studies on the fertilizing capacity of fowl semen.
Protein and energy requirements of laying hens.

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Woodslee (Clay Soils) J. W. Aylesworth, B.S.A., M.S., Officer-in-Charge.
Smithfield, Horticultural Substation, Associated with the Horticulture Division, C. E. Farm, Ottawa, Ontario.

### MANITOBA

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Brandon, Experimental Farm, R. M. Hopper, B.S.A., M.Sc., Superintendent.
Associated Substations: Melita (Reclamation); Wabowden (Virgin Soils).
Portage la Prairie (Special Crops) E. M. MacKey, B.S.A., Officer-in-Charge.
Winnipeg, Cereal Breeding Laboratory, R. F. Peterson, B.S.A., M.Sc., Ph.D., Officer-in-Charge, Associated with the Cereal Division, C. E. Farm, Ottawa, Ont.

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Saskatoon, Forage Plants Laboratory, J. L. Bolton, B.S.A., M.Sc., Ph.D., Officer-in-Charge.
Associated with the Forage Crops Division, C. E. Farm, Ottawa, Ont.
Swift Current, Soil Research Laboratory, J. L. Doughty, B.S.A., M.Sc., Ph.D., Officer-in-Charge.
Associated with the Field Husbandry Division, C. E. Farm, Ottawa, Ont.

## ALBERTA

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Associated Substation: Vegreville (Solonetz Soils).
Lethbridge, Experimental Farm, H. Chester, B.S.A., Superintendent.
Associated Substation: Vauxhaul (Irrigation) W. L. Jacobson, B.S.A., Officer-in-Charge; Stavely (Range Management).
Beaverlodge, Experimental Farm, E. C. Stacey, B.A., M.Sc., Superintendent.
Manyberries, Range Experimental Farm, H. F. Peters, B.Sc., M.Sc., Superintendent.
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Associated Substation: Boundary Bay (Potatoes).
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Associated Substation: Kelowna (Horticulture).
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Saanichton, Experimental Farm, J. J. Woods, B.S.A., M.S.A., Superintendent.
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